MINISTRY OF ROADS AND TRANSPORT

KAA Kenya Airports Authority

Design, Development & Modernization of Jomo Kenyatta International Airport (JKIA)

Component 3: Development of New Passenger Terminal Building & Associated Airside, Landside & Support Facilities

Component 3A: Development of New Passenger Terminal & Associated Buildings

Volume 2: Specifications

April 2026

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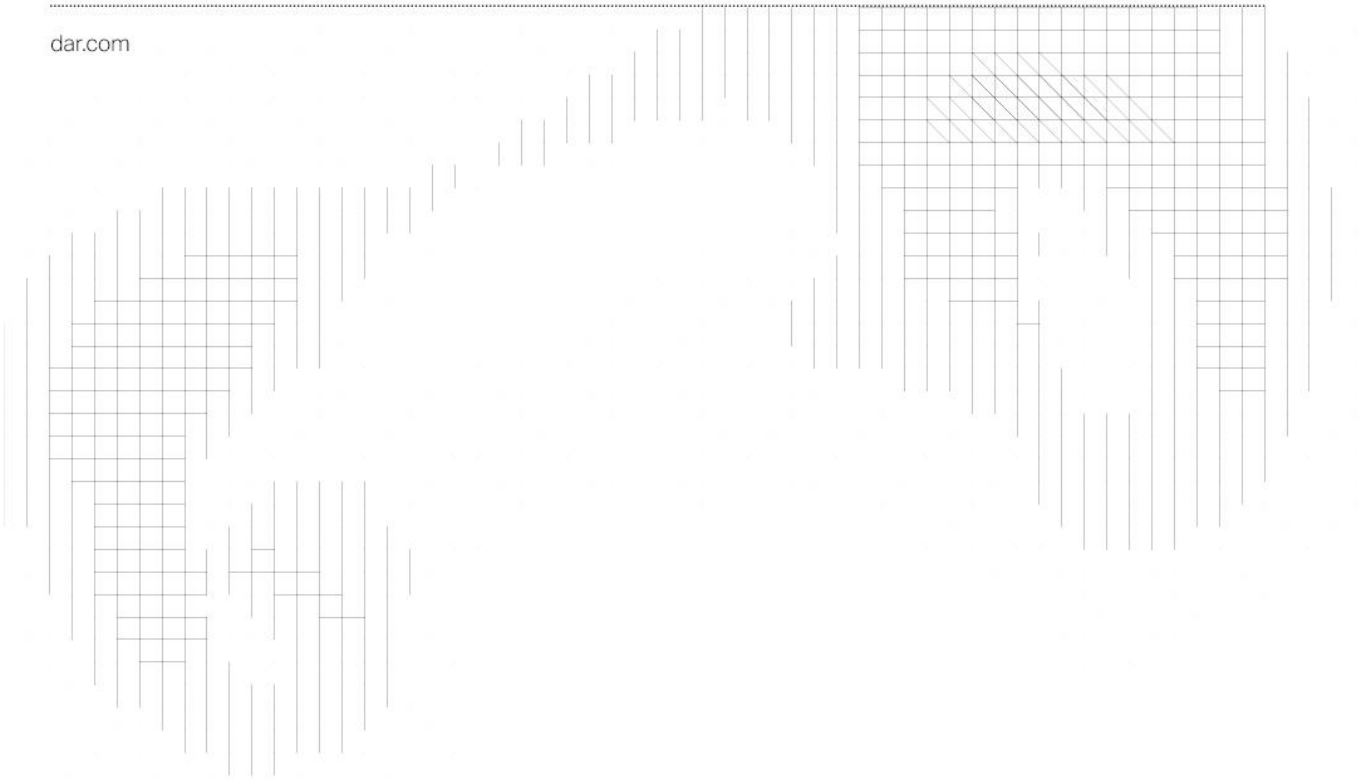

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DSS SENSOR
FDD

es

SECTION 010000 - GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Related Sections:

1. Referenced Sections: List of sections in “Related Sections” or “Related Requirements” is not intended to be exhaustive or mutually exclusive, it is meant for reference and guidance only by way of assistance.
2. Missing References: In case a section or part thereof is considered missing, this shall be brought to the attention of the Engineer.
3. The several documents forming the Contract are to be taken as mutually explanatory of one another; however, in case of ambiguities or discrepancies the same shall be explained and adjusted by the Engineer who shall thereupon issue to the Contractor instructions thereon and in such event, unless otherwise provided in the contract.
4. Liability for Missing References: A full understanding and appreciation of the full provisions included in all the specification sections and the interaction between these sections is required. References to related sections are provided for assistance only and no liability for any coordination issues related references which are deemed missing from “Related Sections” or “Related Requirements” parts of the Specification sections shall rest with the Employer.

1.2 DEFINITIONS

A. Specification sections use the terms "Engineer" in lieu of “Architect”, and "Employer" in lieu of “Owner”. In case the terms “Architect” and “owner” still exist in some sections, they are deemed to mean "Engineer" and "Employer” respectively.

1.3 QUALITY ASSURANCE

1. Industry Standards: When both U.S. and European, Industry Standards are applicable to this project and the standards are in conflict with each other, the most stringent of the industry standards shall govern.
2. Source Limitations: Obtain all system components and accessories from single source from single manufacturer. If some components are not produced by system manufacture, obtaining these components from other sources may be approved subject to recommendation in writing by system manufacturer provided it does not negate the warranty. Submit for Engineer’s approval.
3. Oversize Fire-Rated Doors: For units exceeding sizes of tested assemblies provide certification by a qualified testing agency that doors comply with standard construction requirements for tested and labeled fire-rated door assemblies except for size.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 010000

SECTION 011000 - SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions and other Division 01 Specifications sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Project information.
2. Work covered by contract documents.
3. Phased construction / work sequence.
4. Work performed by employer.
5. Multiple work packages.
6. Work under employer's separate contracts.
7. Future work (not part of this project).
8. Employer's product purchase contracts.
9. Employer-Furnished / Contractor-Installed (EFCI) products.
10. Employer-Furnished / Employer-Installed (EFEI) products.
11. Contractor-Furnished / Employer-Installed (CFEI) products.
12. Access to site.
13. Contractor's use of site and premises.
14. Coordination with occupants.
15. Work restrictions.
16. Specification and drawing conventions.
17. Miscellaneous provisions.

B. Related Requirements:

1. Section 011200 “Multiple Contract Summary”.
2. Section 015000 "Temporary Facilities and Controls" for limitations and procedures governing temporary use of Employer's facilities.
3. Section 017300 "Execution" for coordination of Employer-installed products.

1.3 DEFINITIONS

A. Work Package: A group of specifications, drawings, and schedules prepared by the design team to describe a portion of the Project Work for pricing, permitting, and construction.

1.4 PROJECT INFORMATION

Project Identification: <The project comprises the construction of JKIA new terminal building. Known as Phase 2, the project focuses on the development of a new passenger terminal building with the associated airport support facilities and landside access.

The development is planned to accommodate up to 15 million passengers annually, with Phase 1 designed for 10 million passengers and Phase 2 expanding capacity to 15 million passengers, ensuring scalability and long-term operational resilience. The terminal building will manage the following passenger flows:

serve the optimized passenger terminal buildings in addition to improvements to the airfield to increase the existing runway capacity.

A. .Project Location: **Jomo Kenyatta International Airport, Nairobi, Kenya)** as more particularly shown on the Location Plan included in the Contract Drawings.

B. Employer: **Government of Kenya**.

C. Design-Builder::

1. Design-Builder has been engaged for this Project to provide architectural and engineering services and to serve as Project's constructor. In the specification sections, the terms "design-builder" and "Contractor" are synonymous. Other Employer Consultants: Employer has retained the following design professionals who have prepared designated portions of the Contract Documents.

1.5 WORK COVERED BY CONTRACT DOCUMENTS

A. The Work of Project is defined by the Contract Documents and includes, but is not limited to, the following:

1. The development of new passenger terminal and associated airside, landside and support facilities.
2. The development is planned to accommodate up to 15 million passengers annually, with Phase 1 designed for 10 million passengers and Phase 2 expanding capacity to 15 million passengers, ensuring scalability and long-term operational resilience. The terminal building will manage the following passenger flows:
   - Domestic Flights – Arrivals and Departures
   - International Flights – Arrivals and Departures
   - Transfer Flights – International Connections
3. The proposed Terminal Building adopts an X-shaped configuration, designed to efficiently serve 10 million passengers per annum (MPPA) in Phase I, with expansion capacity to 15 MPPA at the ultimate phase.
4. The new terminal will cater for Central Processing Area; International Piers (Front Piers); Domestic Piers (Side Piers); Arrivals Hall; Support and Service Areas; Public Facilities
5. The new terminal development at JKIA will include a range of support facilities to ensure efficient operations, passenger convenience, and compliance with international standards. These facilities include:
   - Administrative and Operational Offices
   - Aircraft Cleaning Facilities
   - Airport Maintenance Complex
   - Airside Bus Facilities
   - ARFF (Aircraft Rescue and Firefighting) Facilities
   - Catering Facility
   - GSE Maintenance Facility
   - AS/LS Gates (Airside/Landside Gates)
   - Aircraft Maintenance Hangar:
   - Data Centers:
6. Works include all Other Work indicated in the Employer's Requirements.
7. Where the Project, or any part thereof, is designated as pursuing a sustainability rating or certification, the Contractor shall develop, submit, and implement a Sustainability Construction Strategy that is fully aligned with and derived from the approved design sustainability requirements of the Project and aligned with the targeted sustainability rating. The Sustainability Construction Strategy shall translate the design-stage sustainability objectives, criteria, and commitments into construction-phase methods, controls, responsibilities, monitoring procedures, and documentation necessary to support achievement of the targeted sustainability certification. The Contractor shall not modify, dilute, or contradict the approved design sustainability requirements. Any proposed alternative measures shall be subject to prior written approval by the Employer.

B. Type of Contract:

1. Project will be constructed under a single prime contract.

1.6 WORK UNDER EMPLOYER'S SEPARATE CONTRACTS

A.]

B. Concurrent Work: Employer **has awarded** separate contract(s) for construction operations at Project site. Those operations will be conducted simultaneously with Work under this Contract.

C. Subsequent Work: Employer **will award** separate contract(s) for additional work to be performed at site following Substantial Completion. Completion of that work will depend on successful completion of preparatory Work under this Contract.

1.7 EMPLOYER'S PRODUCT PURCHASE CONTRACTS

A. Employer has negotiated Product Purchase contracts with suppliers of material and equipment to be incorporated into the Work. Employer will assign these Product Purchase contracts to Contractor. Include costs for purchasing, receiving, handling, storage if required, and installation of material and equipment in the Contract Sum unless otherwise indicated.

1. Contractor's responsibilities are same as if Contractor had negotiated Product Purchase contracts, including responsibility to renegotiate purchase and to execute final purchasing agreements.

1.8 EMPLOYER-FURNISHED / CONTRACTOR-INSTALLED (EFCI) PRODUCTS

A. Employer's Responsibilities: Employer will furnish products indicated and perform the following, as applicable:

1. Provide to Contractor Employer-reviewed Product Data, Shop Drawings, and Samples.
2. Provide for delivery of Employer-furnished products to Project site.
3. Upon delivery, inspect, with Contractor present, delivered items.

1.9 FUTURE WORK

A. Other Contracts: Cooperate fully and coordinate with separate contracts and program the Works so that work on those contracts may be carried out efficiently and effectively, without interfering with or delaying work under this Contract.

B. Future Contracts: Employer reserves the right to perform additional work and / or award further separate contracts for performance of additional work at the Project site; whether concurrently with, or after Substantial Completion of, Work under this Contract. Performance and completion of such additional work may depend on successful completion of preparatory work under this Contract.

C. Cooperate fully and coordinate with any future construction forces and / or separate contractors or any entity engaged by the Employer, including, but not limited to, operators andfacility managers as necessary, and program the Works so far as reasonably possible so that work on those contracts may be carried out efficiently and effectively, without interfering with or delaying work under this Contract.

1.10 EMPLOYER'S PRODUCT PURCHASE CONTRACTS

A. Employer has negotiated Product Purchase contracts with suppliers of material and equipment to be incorporated into the Work. Employer will assign these Product Purchase contracts to Contractor. Include costs for purchasing, receiving, handling, storage if required, and installation of material and equipment in the Contract Sum unless otherwise indicated.

1. Contractor's responsibilities are same as if Contractor had negotiated Product Purchase contracts, including responsibility to renegotiate purchase and to execute final purchasing agreements.

1.11 EMPLOYER-FURNISHED / CONTRACTOR-INSTALLED (EFCI) PRODUCTS

A. Employer's Responsibilities: Employer will furnish products indicated and perform the following, as applicable:

1. Provide to Contractor Employer-reviewed Product Data, Shop Drawings, and Samples.
2. Provide for delivery of Employer-furnished products to Project site.
3. Upon delivery, inspect, with Contractor present, delivered items.

    a. If Employer-furnished products are damaged, defective, or missing, arrange for replacement.

4. Obtain manufacturer's inspections, service, and warranties.
5. Inform Contractor of earliest available delivery date for Employer-furnished products.

B. Contractor's Responsibilities: The Work includes the following, as applicable:

1. Designate delivery dates of Employer-furnished products in Contractor's construction schedule, utilizing Employer-furnished earliest available delivery dates.
2. Review Employer-reviewed Product Data, Shop Drawings, and Samples, noting discrepancies and other issues in providing for Employer-furnished products in the Work.
3. Receive, unload, handle, store, protect, and install Employer-furnished products.
4. Make building services connections for Employer-furnished products.
5. Protect Employer-furnished products from damage during storage, handling, and installation and prior to Substantial Completion.
6. Repair or replace Employer-furnished products damaged following receipt.

1.12 ACCESS TO SITE

A. General: Contractor shall use the Project site for the execution of the Works and for access thereto. Contractor's use of Project site is limited only by Employer's right to perform work or to retain other contractors on portions of Project. The project site shall be shared with other contractors if employed directly by the Employer as required. Access to the project Site may need to be shared / coordinated with other contractors executing adjacent or related works.

1.13 CONTRACTOR'S USE OF SITE AND PREMISES

A. Unrestricted Use of Site: **Each** Contractor shall have full use of Project site for construction operations during construction period. Contractor's use of Project site is limited only by Employer's right to perform work or to retain other contractors on portions of Project.

B. Restricted Use of Site: **Each** Contractor shall have limited use of Project site for construction operations as indicated on Drawings by the Contract limits and as indicated by requirements of this Section.

C. Limits on Use of Site: Limit use of Project site to **Work in areas** indicated. Do not disturb portions of Project site beyond areas in which the Work is indicated.

1. Limits on Use of Site: Confine construction operations to to site boundaries.
2. Driveways, Walkways and Entrances: Keep driveways **parking garage, loading areas,** and entrances serving premises clear and available to Employer, Employer's employees, other contractors, and emergency vehicles at all times. Do not use these areas for parking or for storage of materials.

    a. Schedule deliveries to minimize use of driveways and entrances by construction operations.
    b. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

3. Employer Occupancy: Allow for Employer occupancy of project site.

D. Condition of Existing Building: Maintain portions of existing building affected by construction operations in a weathertight condition throughout construction period. Repair damage caused by construction operations.

E. Condition of Existing Grounds: Maintain portions of existing grounds, landscaping, and hardscaping affected by construction operations throughout construction period. Repair damage caused by construction operations.

1.14 COORDINATION WITH OCCUPANTS

A. Full Employer Occupancy: Employer will occupy Project site and**adjacent** building(s) during entire construction period. Cooperate with Employer during construction operations to minimize conflicts and facilitate Employer usage. Perform the Work so as not to interfere with Employer's day-to-day operations. Maintain existing exits unless otherwise indicated.

1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Employer and approval of authorities having jurisdiction.
2. Notify Employer not less than **72** hours in advance of activities that will affect Employer's operations.

B. Partial Employer Occupancy: Employer will occupy the premises during entire construction period, with the exception of areas under construction. Cooperate with Employer during construction

operations to minimize conflicts and facilitate Employer usage. Perform the Work so as not to interfere with Employer's operations. Maintain existing exits unless otherwise indicated.

1. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Employer and authorities having jurisdiction.
2. Provide not less than **72** hours' notice to Employer of activities that will affect Employer's operations.
3. Partial Owner occupancy of any completed portion of the Work shall not constitute or be construed as Sectional Completion as long as this partial occupation is for temporary reasons and provided that it does not preclude / hinder the Contractor's progress at these spaces.
4. No separate Sectional Taking-Over Certificate shall be issued in connection with such partial occupancy.

C. Employer Limited Occupancy of Completed Areas of Construction: Employer reserves the right to occupy and to place and install equipment in completed portions of the Work, prior to Substantial Completion of the Work, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and limited occupancy shall not constitute acceptance of the total Work.

1. Engineer will prepare a Certificate of Substantial Completion for each specific portion of the Work to be occupied prior to Employer acceptance of the completed Work.
2. Obtain a Certificate of Occupancy from authorities having jurisdiction before limited Employer occupancy.
3. Before limited Employer occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. On occupancy, Employer will operate and maintain mechanical and electrical systems serving occupied portions of Work.
4. On occupancy, Employer will assume responsibility for maintenance and custodial service for occupied portions of Work.

1.15 WORK RESTRICTIONS

A. Comply with restrictions on construction operations.

1. Comply with limitations on use of public streets, work on public streets, rights of way, and other requirements of authorities having jurisdiction.

B. On-Site Workday Restrictions: Do not perform work **resulting in utility shutdownsor resulting in noisy activity** on-site during work black-out days defined by the Employer.

C. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by Employer or others unless permitted under the following conditions and then only after arranging for temporary utility services according to requirements indicated:

1. Notify **Engineer Construction Manager Employer** not less than [**two**] days in advance of proposed utility interruptions.
2. Obtain **Engineer's**] written permission before proceeding with utility interruptions.

D. Noise, Vibration, Dust, and Odors: Coordinate operations that may result in high levels of noise and vibration, dust, odors, or other disruption to Employer occupancy with Employer.

1. Notify **Engineer**not less than **two** days in advance of proposed disruptive operations.
2. Obtain **Engineer's** written permission before proceeding with disruptive operations.
3. Minimizing Noise levels
4. Eliminating water/air pollution.

E. Nonsmoking Building: Smoking is not permitted within the building or within 25 feet (8 m) of entrances, operable windows, or outdoor air intakes.

F. Smoking and Controlled Substance Restrictions: Use of tobacco products [**, alcoholic beverages,**] and other controlled substances **on Project site** is not permitted.

G. Employee Identification: **Provide**] identification tags for Contractor personnel working on Project site. Require personnel to use identification tags at all times.

H. Employee Screening: Comply with Employer's requirements for **drug and background** screening of Contractor personnel working on Project site.

1. Maintain list of approved screened personnel with Employer's representative.

1.16 SPECIFICATION AND DRAWING CONVENTIONS

A. Specification Content: The Specifications use certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

1. Imperative mood and streamlined language are generally used in the Specifications. The words "shall," "shall be," or "shall comply with," depending on the context, are implied where a colon (:) is used within a sentence or phrase.
2. Text Color: Text used in the Specifications, including units of measure, manufacturer and product names, and other text may appear in multiple colors or underlined as part of a hyperlink; no emphasis is implied by text with these characteristics.
3. Hypertext: Text used in the Specifications may contain hyperlinks. Hyperlinks may allow for access to linked information that is not residing in the Specifications. Unless otherwise indicated, linked information is not part of the Contract Documents.
4. Specification requirements are to be performed by the Contractor unless specifically stated otherwise.

B. General provisions of the Contract, including General, Particular and Supplementary Conditions, apply to all Sections of the Specifications.

C. Division 01 General Requirements: Requirements of Sections in Division 01 apply to the Work of all Sections in the Specifications.

D. Drawing Coordination: Requirements for materials and products identified on Drawings are described in detail in the Specifications. One or more of the following are used on Drawings to identify materials and products:

1. Terminology: Materials and products are identified by the typical generic terms used in the individual Specifications Sections.
2. Abbreviations: Materials and products are identified by abbreviations **scheduled on Drawingsandpublished as part of the U.S. National CAD Standard**.
3. Keynoting: Materials and products are identified by reference keynotes referencing Specification Section numbers found in this Project Manual.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011000

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SECTION 011200 - MULTIPLE CONTRACT SUMMARY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions and other Division 01 Specifications sections, apply to this Section.

1.2 SUMMARY

A. Section includes a summary of each contract, including responsibilities for coordination and temporary facilities and controls.

B. Specific requirements for Work of each contract are also indicated in individual Specification Sections and on Drawings.

C. Related Requirements:

1. Division 01, Section 011000 "Summary" for the Work covered by the Contract Documents, restrictions on use of Project site, phased construction, coordination with occupants, and work restrictions.
2. Division 01, Section 013100 "Project Management and Coordination" for general coordination requirements.
3. Division 01, Section 013200 "Construction Progress Documentation" for preparation and submittal of Construction Programs.
4. Division 01 Section 015000 "Temporary Facilities and Controls" for specific requirements for temporary facilities and controls.

1.3 DEFINITIONS

A. Permanent Enclosure: As determined by the Engineer, the condition at which roofing is insulated and weathertight; exterior walls are insulated and weathertight; and openings are closed with permanent construction or substantial temporary closures equivalent in weather protection to permanent construction.

1.4 PROJECT COORDINATOR

A. Project coordinator shall be responsible for coordination between the General Construction Contract and all other Contractors and Sub-Constractors onsite.

1.5 PROJECT COORDINATOR RESPONSIBILITIES

A. Project coordinator: The Contractor shall appoint a full-time Coordinator for the Works. Such coordinator shall be experienced in administration and supervision of civil and building construction, including mechanical and electrical work.

B. The project coordinator shall perform Project coordination activities for the multiple contracts, including, but not limited to, the following:

1. Provide typical overall coordination of the Work.

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2. Coordinate shared access to workspaces.
3. Coordinate product selections for compatibility.
4. Provide overall coordination of temporary facilities and controls.
5. Coordinate, schedule, and approve interruptions of permanent and temporary utilities, including those necessary to make connections for temporary services.
6. Coordinate construction and operations of the Work with work performed by each Contract and the Employer's construction forces.
7. Prepare coordination drawings in collaboration with each contractor to coordinate work by more than one contract.
8. Coordinate sequencing and scheduling of the Work. Include the following:

    a. Initial Coordination Meeting: At earliest possible date, arrange and conduct a meeting with contractors for sequencing and coordinating the Work; negotiate reasonable adjustments to schedules.
    b. Prepare combined Contractors' Construction Schedule for entire Project in coordination with the Employer's scheduling consultant. Base schedule on preliminary construction schedule. Secure time commitments for performing critical construction activities from contractors. Show activities of each contract on a separate sheet. Prepare a simplified summary sheet indicating combined construction activities of contracts.

        1. Submit schedules for approval.
        2. Distribute copies of approved schedules to contractors.

9. Provide photographic documentation.
10. Provide quality-assurance and quality-control services specified in Section 014000 "Quality Requirements."
11. Coordinate sequence of activities to accommodate tests and inspections, and coordinate schedule of tests and inspections.
12. Provide information necessary to adjust, move, or relocate existing utility structures affected by construction.
13. Locate existing permanent benchmarks, control points, and similar reference points, and establish permanent benchmarks on Project site.
14. Provide field surveys of in-progress construction and site work and final property survey.
15. Provide progress cleaning of common areas and coordinate progress cleaning of areas or pieces of equipment where more than one contractor has worked.
16. Coordinate cutting and patching.
17. Coordinate protection of the Work.
18. Coordinate firestopping.
19. Coordinate completion of interrelated punch list items.
20. Coordinate preparation of Project Record Documents if information from more than one contractor is to be integrated with information from other contractors to form one combined record.
21. Print and submit Record Documents if installations by more than one contractor are indicated on the same Contract Drawing or Shop Drawing.
22. Collect record Specification Sections from contractors, collate Sections into numeric order, and submit complete set.
23. Coordinate preparation of operation and maintenance manuals if information from more than one contractor is to be integrated with information from other contractors to form one combined record.

C. Responsibilities of Project coordinator for temporary facilities and controls include, but are not limited to, the following:

    1. Provide common-use field office for use by all personnel engaged in construction activities.
    2. Provide telephone service for common-use facilities.

D. As soon as the Contractor becomes aware of any conflicts between his own program and the programs of any other contractor(s) or persons working on the Site, which cannot be reasonably and

immediately resolved directly between the parties concerned, the Contractor shall report the same to the Engineer for discussion at the Combined Contractors' Meeting. Where any conflict cannot be resolved by mutual agreement of the concerned parties at the Combined Contractors' Meeting, the Engineer shall, after further consultation with such parties, decide and issue his direction or, if necessary, instruction on the matter.

1.6 GENERAL REQUIREMENTS OF CONTRACTS

A. Extent of Contract: Unless the Agreement contains a more specific description of the Work of each Contract, requirements indicated on Drawings and in Specification Sections determine which contract includes a specific element of Project.

1. Unless otherwise indicated, the work described in this Section for each contract shall be complete systems and assemblies, including products, components, accessories, and installation required by the Contract Documents.
2. Trenches and other excavation for the work of each contract shall be the work of the General Construction Contract and each contract for its own work.
3. Blocking, backing panels, sleeves, and metal fabrication supports for the work of each contract shall be the work of the General Construction Contract or each contract for its own work.
4. Furnishing of access panels for the work of each contract shall be the work of each contract for its own work. Installation of access panels shall be the work of General Construction Contract or each contract for its own work.
5. Equipment pads for the work of each contract shall be the work of General Construction Contract or each contract for its own work.
6. Roof-mounted equipment curbs for the work of each contract shall be the work of General Construction Contract or each contract for its own work.
7. Painting for the work of each contract shall be the work of General Construction Contract or each contract for its own work.
8. Cutting and Patching: Provided by the General Construction Contract or under each contract for its own work. Each contract shall perform its own cutting; patching shall be under the General Construction Contract.
9. Through-penetration firestopping for the work of each contract shall be provided by General Construction Contract or each contract for its own work.
10. Taxiways, Aprons, roads, bridges, tunnels, utilities (pure infrastructure works)
12. Contractors' Startup Construction Schedule: Within five working days after startup horizontal bar-chart-type construction schedule and preliminary network diagram submittal has been received from Project coordinator, submit a matching startup horizontal bar-chart schedule and startup network diagram showing construction operations sequenced and coordinated with overall construction.

B. Substitutions: Each contractor shall cooperate with other contractors involved to coordinate approved substitutions with remainder of the work.

1. Project coordinator and/or The General Construction Contract shall coordinate substitutions.

C. Temporary Facilities and Controls: In addition to specific responsibilities for temporary facilities and controls indicated in this Section and in Section 015000 "Temporary Facilities and Controls," each contractor is responsible for the following:

1. Installation, operation, maintenance, and removal of each temporary facility necessary for its own normal construction activity, and costs and use charges associated with each facility, except as otherwise provided for in this Section.
2. Plug-in electric power cords and extension cords, supplementary plug-in task lighting, and special lighting necessary exclusively for its own activities.
3. Its own field office, complete with necessary furniture, utilities, and telephone service.
4. Its own storage and fabrication sheds.
5. Temporary enclosures for its own construction activities.

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6. Staging and scaffolding for its own construction activities.
7. General hoisting facilities for its own construction activities, up to 2 tons.
8. Waste disposal facilities, including collection and legal disposal of its own hazardous, dangerous, unsanitary, or other harmful waste materials.
9. Progress cleaning of work areas affected by its operations on a daily basis.
10. Secure lockup of its own tools, materials, and equipment.
11. Construction aids and miscellaneous services and facilities necessary exclusively for its own construction activities.

D. Temporary Heating, Cooling, and Ventilation: The General Construction Contract is responsible for temporary heating, cooling, and ventilation, including utility-use charges, temporary meters, and temporary connections.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 011200

SECTION 012500 - SUBSTITUTION PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions and other Division 01 Specifications sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for substitutions.

B. Related Requirements:

1. Division 01 Section 011000 "Summary" for Contractor requirements related to Employer-furnished products.
2. Division 01, Section 014200 "References" for applicable industry standards for products specified.
3. Division 01 Section 016000 "Product Requirements" for requirements for submitting comparable product submittals for products by listed manufacturers.
4. Division 01, Section 017700 "Closeout Procedures" for submitting warranties.
5. Division 01 Sections 018113" Sustainable Design Requirements – LEED.
6. Specification Sections for specific requirements for warranties on products and installations specified to be warranted.

1.3 DEFINITIONS

A. Substitutions: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents.

1. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
2. Substitutions for Convenience: Changes proposed by Contractor or Employer that are not required to meet other Project requirements but may offer advantage to Contractor or Employer.

1.4 ACTION SUBMITTALS

A. Substitution Requests: Submit three hard copies and a soft copy thru Web-Based Project Software of each request for consideration Submit documentation identifying product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Substitution Request Form: Use Project form as provided by the Engineer.
2. Documentation: Show compliance with requirements for substitutions and the following, as applicable:

a. Statement indicating why specified product or fabrication or installation method cannot be provided, if applicable.

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b. Coordination of information, including a list of changes or revisions needed to other parts of the Work and to construction performed by Employer and separate contractors that will be necessary to accommodate proposed substitution.
c. Detailed comparison of significant qualities of proposed substitutions with those of the Work specified. Include annotated copy of applicable Specification Section. Significant qualities may include attributes, such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated. Indicate deviations, if any, from the Work specified.
d. Identify product to be replaced. Include detailed comparison in matrix form between specified materials and proposed ones.
e. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
f. Samples, where applicable or requested.
g. Certificates and qualification data, where applicable or requested.
h. List of similar installations for completed projects, with project names and addresses as well as names and addresses of the Engineers and Employers.
i. Material test reports from a qualified testing agency, indicating and interpreting test results for compliance with requirements indicated.
j. Research reports evidencing compliance with building code in effect for Project, from a model code organization acceptable to authorities having jurisdiction.
k. Detailed comparison of Contractor's construction schedule using proposed substitutions with products specified for the Work, including effect on the overall Contract Time. If specified product or method of construction cannot be provided within the Contract Time, include letter from manufacturer, on manufacturer's letterhead, stating date of receipt of purchase order, lack of availability, or delays in delivery.
l. Cost information, including a proposal of change, if any, in the Contract Sum.
m. Contractor's certification that proposed substitution complies with requirements in the Contract Documents, except as indicated in substitution request, is compatible with related materials and is appropriate for applications indicated.
n. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.

3. Engineer's Action: If necessary, the Engineer will request additional information or documentation for evaluation within seven (7) days of receipt of a request for substitution. The Engineer will notify Contractor of acceptance or rejection of proposed substitution within fifteen (15) days of receipt of request, or seven (7) days of receipt of additional information or documentation, whichever is later.

a. Forms of Acceptance: Refer to the Conditions of Contract.
b. Use product specified if the Engineer does not issue a decision on use of a proposed substitution within time allocated.

1.5 QUALITY ASSURANCE

A. Compatibility of Substitutions: Investigate and document compatibility of proposed substitution with related products and materials. Engage a qualified testing agency to perform compatibility tests recommended by manufacturers.

1.6 PROCEDURES

A. Coordination: Revise or adjust affected work as necessary to integrate work of the approved substitutions.

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1.7 SUBSTITUTIONS

A. Substitutions for Cause: Submit requests for substitution immediately on discovery of need for change, but not later than fifteen (15) days prior to time required for preparation and review of related submittals.

1. Conditions: The Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, the Engineer will return requests without action, except to record noncompliance with these requirements:

a. Requested substitution is consistent with the Contract Documents and will produce indicated results.
b. Requested substitution provides sustainable design characteristics that specified product provided for achieving sustainability certifications.
c. Substitution request is fully documented and properly submitted.
d. Requested substitution will not adversely affect Contractor's construction schedule.
e. Requested substitution has received necessary approvals of authorities having jurisdiction.
f. Requested substitution is compatible with other portions of the Work.
g. Requested substitution has been coordinated with other portions of the Work.
h. Requested substitution provides specified warranty.
i. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

2. Time for review and potential delays: Contractor remains responsible for any delays generated by substitution requests, should the substitution be approved or rejected.

B. Substitutions for Convenience: The Engineer will consider requests for substitution if received within sixty (60) days after commencement of the Work. Requests received after that time may be considered or rejected at discretion of the Engineer.

1. Conditions: The Engineer will consider Contractor's request for substitution when the following conditions are satisfied. If the following conditions are not satisfied, the Engineer will return requests without action, except to record noncompliance with these requirements:

a. Requested substitution offers Employer a substantial advantage in cost, time, energy conservation, or other considerations, after deducting additional responsibilities Employer must assume. Employer's additional responsibilities may include compensation to the Engineer for redesign and evaluation services, increased cost of other construction by Employer, and similar considerations.
b. Requested substitution does not require extensive revisions to the Contract Documents.
c. Requested substitution is consistent with the Contract Documents and will produce indicated results.
d. Requested substitution provides sustainable design characteristics that specified product provided for achieving sustainability related certifications.
e. Substitution request is fully documented and properly submitted.
f. Requested substitution will not adversely affect Contractor's construction schedule.
g. Requested substitution has received necessary approvals of authorities having jurisdiction.
h. Requested substitution is compatible with other portions of the Work.
i. Requested substitution has been coordinated with other portions of the Work.
j. Requested substitution provides specified warranty.
k. If requested substitution involves more than one contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all contractors involved.

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2. Time for review and potential delays: Contractor remains responsible for any delays generated by substitution requests, should the substitution be approved or rejected.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 012500

SECTION 013100 - PROJECT MANAGEMENT AND COORDINATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions and other Division 01 Specifications sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative provisions for coordinating construction operations on Project, including, but not limited to, the following:

1. Informational Submittals.
2. General Coordination Procedures.
3. Coordination Drawings.
4. Requests for Information RFIs or (Site Clarification Requests (SCRs).
5. Digital Project Management Procedures.
6. Web-based Project Management Software.
7. Common Data Environment (CDE).
8. Project Meetings.

B. Each contractor shall participate in coordination requirements. Certain areas of responsibility are assigned to a specific contractor.

C. Related Requirements:

1. Division 01, Section 011200 "Multiple Contract Summary" for a description of the division of work among separate contracts and responsibility for coordination activities not in this Section.
2. Division 01, Section 013200 "Construction Progress Documentation" for preparing and submitting Contractor's construction schedule.
3. Division 01, Section 017300 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
4. Division 01, Section 017700 "Closeout Procedures" for coordinating closeout of the Contract.
5. Division 01, Section 019113 "General Commissioning Requirements" for coordinating the Work with the Employer's Commissioning Authority.
6. Specification sections related to the functionality and efficiency of the executed systems.

1.3 DEFINITIONS

A. BIM: Building Information Modeling.

B. RFI: Request for Information. Request from the Employer, Construction Manager, or Contractor seeking information required by or clarifications of the Contract Documents. Request For Information (RFI) is called also Site clarification Request (SCR).

C. DTRD (Digital Twin Ready Design): Digital Twin is a virtual model of a physical object or system that spans its lifecycle and uses real-time data sent from sensors on the object to simulation the behavior and monitor operation. Digital Twin lays the groundwork for the creation of a common data environment (CDE), a centralized database including technical documentation, maintenance

records, live data so on with 3d contextualization all accessible from the digital twin platform. It also includes the preparation of a strategy report which defines the features/ use cases that align with the client's vision and expectations.

1.4 INFORMATIONAL SUBMITTALS

A. Subcontract List: Prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:

1. Name, address, telephone number, and email address of entity performing subcontract or supplying products.
2. Number and title of related Specification Section(s) covered by subcontract.
3. Drawing number and detail references, as appropriate, covered by subcontract.

B. Key Personnel Names: Within fifteen (15) days of starting construction operations, submit a list of key personnel assignments, including superintendent and other personnel in attendance at Project site. Identify individuals and their duties and responsibilities, list addresses, cellular telephone numbers, and e-mail addresses. Provide names, addresses, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

1. Post copies of list in Project meeting room, in temporary field office, in web-based Project software directory, and in prominent location in each built facility. Keep list current at all times.

2. Attach curricula vitae for individuals assigned to the following or equivalent staff positions or to any other key positions assigned to the Project to include details of education and qualifications; a brief career history including employment, experience and present position; note special skills and abilities.

    a. Project Manager
    b. Design Manager
    c. Construction Manager
    d. HSSE Manager
    e. LEED Coordinator
    f. Coordinator
    g. BIM Manager
    h. BIM Coordinator(s)
    i. Interface Coordinator
    j. QA/QC Manager
    k. Procurement Manager
    l. Administration Manager
    m. Document Control Supervisor.
    n. Safety / Security Manager
    o. Site Superintendent(s)
    p. Deputy Superintendent(s)
    q. Supervising Engineers
    r. Construction Supervisors

3. The key personnel should not be replaced during the project’s duration, unless requested by the client. Any replacement should be provided within one month’s prior notice with the relevant qualifications and experience agreed by the Client.

1.5 GENERAL COORDINATION PROCEDURES

A. Coordination: Coordinate construction operations included in different sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction

operations included in different Sections that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results, whereas installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.

B. Coordination of Multiple Contracts: Each contractor shall cooperate with Project coordinator, who shall coordinate its construction operations with those of other contractors and entities to ensure efficient and orderly installation of each part of the Work. Each contractor shall coordinate its own operations with operations included in different Sections that depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain the best results, where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components with other contractors to ensure maximum performance and accessibility for required maintenance, service, and repair.
3. Make adequate provisions to accommodate items scheduled for later installation.
4. Coordinate shared access to Site, staging areas and workspaces.
5. Coordinate provision of temporary facilities and controls.
6. Coordinate and schedule interruptions of temporary utilities, including those necessary to make connections for permanent services.
7. Coordinate sequence of activities to accommodate tests and inspections, and coordinate schedule of tests and inspections.
8. Coordinate progress cleaning of common areas.
9. Coordinate protection and security of the Works.
10. Coordinate preparation and submittal of Record (As-Built) Documents and BIM Model ready for integration with Digital Twin Platform.
11. Coordinate preparation and submittal of operation and maintenance manuals.
12. During the installation, testing and commissioning of the Works, cooperate fully with the other contractors' and operators' teams and provide guidance in respect of the planning and organization, as well as the implementation of the commissioning programme as a whole. Ensure that the programme for the Works and its associated commissioning obligations are compatible with those of other contractors.

C. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

1. Prepare similar memoranda for the Employer and separate contractors if coordination of their Work is required.

D. Administrative Procedures: Coordinate scheduling and timing of required administrative procedures with other construction activities and scheduled activities of other contractors and direction of Project coordinator to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of Contractor's construction schedule.
2. Preparation of the schedule of values.
3. Installation and removal of temporary facilities and controls.
4. Delivery and processing of submittals.
5. Progress meetings.
6. Preinstallation conferences.
7. Project closeout activities.
8. Startup and adjustment of systems.

E. Contractor shall, in continuation to the BIM Model prepared by the Engineer (if available), be responsible for enabling, creating and delivering project 3D models that increase in detail from a design status to shop drawings and as built status (LOD 400 & 500). Contractor's BIM deliverables shall be in line with requirements set in subsequent sections of the specifications. Among other requirements, Contractor's scope shall include to a minimum the following:

1. During construction, Contractor will be responsible for providing fully coordinated and assembled LOD 400 and LOD 500 models that are consistent with the EIR (Exchange Information Requirements) document and project specifications.
2. Contractor shall include BIM status in the progress meetings for the Engineer's review. BIM status must include clash detection, model view definitions and other requirements.
3. Contractor shall link all activities of the construction program to Model Elements using specialized software such as Revit or approved similar. The intent is to look ahead at Construction sequences within progress meetings to look at options and opportunities to optimize workflow and minimize risks.

F. During the design stage, Contractor shall submit a design BIM model to reflect the asset management strategy early on from the design stage. by following the below listed set of guidelines and considerations:

1. Classify and organize BIM digital assets (3D families) with relevant geometry / information as per defined DT use cases
2. Provide different virtual zoning entities and sub-entities (facilities, floors, zones, spaces, etc.). These zoning entities will be modeled as 3D volumes and assigned specific ID's for mapping with the digital platform for enhanced visualizations such as energy/lighting heatmaps for example
3. Modeling new elements/provisions for future Digital Twin applications.
4. Model preparation for COBie schema for flexibility of integration with different digital platforms. The COBie schema will also provide the asset grouping breakdown structure in a parent-child data link.

1.6 COORDINATION DRAWINGS

A. Coordination Drawings, General: Prepare coordination drawings according to requirements in individual sections and which have been analyzed, developed and extracted from the Composite BIM Models / Project Information Model (PIM) and additionally where installation is not completely indicated on Shop Drawings, where limited space availability necessitates coordination, or if coordination is required to facilitate integration of products and materials fabricated or installed by more than one entity.

1. Content: Project-specific information, drawn accurately to a scale large enough to indicate and resolve conflicts. Do not base coordination drawings on standard printed data. Include the following information, as applicable:

   a. Use applicable Federated BIM Model NWD format, Composite BIM Models and Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe the relationship of various systems and components.
   b. Use applicable Drawings as a basis for preparation of coordination drawings. Prepare sections, elevations, and details as needed to describe relationship of various systems and components.
   c. Coordinate the addition of trade-specific information to coordination drawings [by multiple contractors]in a sequence that best provides for coordination of the information and resolution of conflicts between installed components before submitting for review.
   d. Coordinate the addition of trade-specific information to coordination drawings [by multiple contractors] in a sequence with Federated BIM Model NWD format fully integrated with Digital Twin Model and drawings that best provides for coordination

of the information and resolution of conflicts between installed components before submitting for review.

e. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
f. Indicate space requirements for routine maintenance and for anticipated replacement of components during the life of the installation.
g. Show location and size of access doors required for access to concealed dampers, valves, and other controls.
h. Indicate required installation sequences.
i. Indicate dimensions shown on Drawings. Specifically note dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternative sketches to the Engineer indicating proposed resolution of such conflicts. Minor dimension changes and difficult installations will not be considered changes to the Contract.

B. Coordination Drawing Organization: Organize coordination drawings as follows:

1. Floor Plans and Reflected Ceiling Plans: Show architectural and structural elements, and mechanical, plumbing, fire-protection, fire-alarm, and electrical Work. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work. Floors / Screed Combined Carpet Plans to be coordinated with Architectural and ID layouts.
2. Plenum Space: Indicate sub framing for support of ceiling**,** raised access floor, and wall systems, mechanical and electrical equipment, and related Work. Locate components within plenums to accommodate layout of light fixtures and other components indicated on Drawings. Indicate areas of conflict between light fixtures and other components.
3. Mechanical Rooms: Provide coordination drawings for mechanical rooms, showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
5. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
6. Mechanical and Plumbing Work: Show the following:

    a. Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
    b. Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
    c. Fire-rated enclosures around ductwork.

7. Electrical Work: Show the following:

    a. Runs of vertical and horizontal conduit thirty-two (32)]mm in diameter and larger.
    b. Light fixture, exit light, emergency battery pack, smoke detector, and other fire-alarm locations.
    c. Panel board, switchboard, switchgear, transformer, busway, generator, and motor-control center locations.
    d. Location of pull boxes and junction boxes, dimensioned from column center lines.

8. Fire-Protection System: Show the following:

    a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.

9. Review: The Engineer will review Federated BIM Model NWD format and coordination drawings to confirm that, in general, the Work is being coordinated, but not for the details of the coordination, which are Contractor's responsibility. If the Engineer determines that coordination drawings and the Federated BIM Model NWD format are not being prepared

in sufficient scope or detail, or are otherwise deficient, the Engineer will so inform Contractor, who shall make suitable modifications and resubmit.]

10. Coordination Drawing Prints: Prepare coordination drawing prints according to requirements in Section 013300 "Submittal Procedures."
11. Combined services drawings to include all services.

C. Coordination Drawing Process: Prepare coordination drawings in the following manner:

1. Schedule submittal and review of Fire Sprinkler, Plumbing, HVAC, and Electrical Shop Drawings to make required changes prior to preparation of coordination drawings.
2. Commence routing of coordination drawing files with HVAC Installer, who will provide drawing plan files denoting approved ductwork. HVAC Installer will locate ductwork and piping on a single layer, using orange color. Forward drawings to Plumbing Installer.
3. Plumbing Installer will locate plumbing and equipment on a single layer, using blue color.
4. Fire Sprinkler Installer will locate piping and equipment, using red color. Fire Sprinkler Installer shall forward drawing files to Electrical Installer.
5. Electrical Installer will indicate service and feeder conduit runs and equipment in green color. Electrical Installer shall forward drawing files to Communications and Electronic Safety and Security Installer.
6. Communications and Electronic Safety and Security Installer will indicate cable trays and cabling runs and equipment in purple color. Communications and Electronic Safety and Security Installer shall forward completed drawing files to Contractor.
7. Contractor shall perform the final coordination review. As each coordination drawing is completed, Contractor will meet with the Engineer to review and resolve conflicts on the coordination drawings.

D. Coordination Digital Data Files: Prepare coordination digital data files according to the following requirements:

1. File Preparation Format:

    a. Same digital data software program, version, and operating system as original Drawings and operating system.
    b. AutoCAD Version as advised by the Engineer.

2. File Submittal Format: Submit or post coordination BIM Models and drawing files using format same as original BIM Model file preparation format, in addition to NWD format and Portable Data File (PDF) format – as per section 013300 and its Annexes.
3. [File Submittal Format: Submit or post coordination drawing files using format same as file preparation format, in addition to PDF format.
4. [BIM File Incorporation: Develop, coordinate and extract Coordination Drawing files from Building Information Model (BIM) established for the Project in accordance with the Section's Annexes of Section 013300 and in the same digital data software program, version, and operating system as the original Drawings.]

    a. [Perform] [Construction Manager will perform] Federated BIM Model(s) three-dimensional component conflict analysis as part of preparation of coordination drawings. Resolve component conflicts prior to submittal. Extract all drawings from the BIM Model, unless otherwise agreed by Engineer. Indicate where conflict resolution requires modification of design requirements by the Engineer.]

5. Engineer will furnish the Contractor one set of digital data files of Drawings for use in preparing coordination digital data files.

    a. Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to Drawings.
    b. Digital Data Software Program: Drawings are available in digital data software program

c. Contractor shall execute a data licensing agreement in the form of AIA Document C106 or Agreement included in this Project Manual or Agreement form acceptable to Employer and Engineer.

1.7 REQUEST FOR INFORMATION (RFI)

A. General: Immediately on discovery of the need for additional information, clarification, or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.

1. Engineer will return without response those RFIs submitted to the Engineer by other entities controlled by Contractor.
2. Coordinate and submit RFIs in a prompt manner to avoid delays in Contractor's work or work of subcontractors.

B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:

1. Project name.
2. The Employer names.
3. The Employer's Project number.
4. Name of the Engineer and Construction Manager
5. Engineer's Project number.
6. Date.
7. Name of Contractor.
8. RFI number, numbered sequentially.
9. RFI subject.
10. Specification Section number and title and related paragraphs, as appropriate.
11. Drawing number and detail references, as appropriate.
12. Field dimensions and conditions, as appropriate.
13. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
14. Contractor's signature.
15. Attachments: Include Federated BIM Model NWD Viewpoints, sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.

    a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

C. RFI Forms: Software-generated form with substantially the same content as indicated above, acceptable to the Engineer.

1. Attachments shall be electronic files in PDF format.

D. Where applicable RFI forms shall include attachments and / or drawings extracted from BIM models for coordination and clarification purposes.

E. Engineer’s and Construction Manager's Action: The Engineer and Construction Manager will review each RFI, determine action required, and respond. Allow seven (7) days for the Engineer's response for each RFI. RFIs received by the Engineer or Construction Manager after one (1:00) p.m. will be considered as received the following working day.

1. The following Contractor-generated RFIs will be returned without action:

    a. Requests for approval of submittals.
    b. Requests for approval of substitutions.
    c. Requests for approval of Contractor's means and methods.

d. Requests for coordination information already indicated in the Contract Documents.
e. Requests for adjustments in the Contract Time or the Contract Sum.
f. Requests for interpretation of the Engineer's actions on submittals.
g. Incomplete RFIs or inaccurately prepared RFIs.

2. Engineer's action may include a request for additional information, in which case the Engineer's time for response will date from time of receipt by the Engineer or Construction Manager of additional information.
3. Engineer's action on RFIs that may result in a change to the Contract Period, or the Contract Sum may be eligible for Contractor to submit Change Proposal to the Employer or Engineer's approval.

a. If Contractor believes the RFI response warrants change in the Contract Period or the Contract Sum, notify the Engineer and Construction Manager in writing within five (5) days of receipt of the RFI response.

F. RFI Log: Prepare, maintain, and submit a tabular log of RFIs organized by the RFI number. Submit log weekly. Use software log that is part of web-based Project software. Include the following:

1. Project name.
2. Name and address of Contractor.
3. Name and address of the Engineer and Construction Manager
4. RFI number, including RFIs that were returned without action or withdrawn.
5. RFI description.
6. Date the RFI was submitted.
7. Date Engineer's and Construction Manager's response was received.
8. Identification of related Minor Change in the Work, Construction Change Directive, and Proposal Request, as appropriate.
9. Identification of related Field Order, Work Change Directive, and Proposal Request, as appropriate.

G. On receipt of the Engineer and Construction Manager's action, update the RFI log and immediately distribute the RFI response to affected parties. Review response and notify the Engineer and Construction Manager within seven (7) days if Contractor disagrees with response.

1.8 DIGITAL PROJECT MANAGEMENT PROCEDURES

A. The Data Files are not available: The Engineer / Employer will not provide BIM model/CAD drawing digital data files for Contractor's use during construction.

B. Use of the Digital Data Files: Digital data files of the BIM model/CAD drawings will be provided by the Engineer / Employer for Contractor's use during construction.

1. Digital data files may be used by Contractor in preparing coordination drawings, Shop Drawings, and Project Record Drawings.
2. Engineer makes no representations as to the accuracy or completeness of digital data files as they relate to Contract Drawings.
3. Digital Drawing Software Program: Contract Drawings are available in digital drawing software program and operating system.
4. Contractor shall execute a data licensing agreement in the form of AIA Document C106 Digital Data Licensing Agreement or Agreement included in Project Manual or Agreement form acceptable to the Employer and Engineer .

a. Subcontractors and other parties granted access by Contractor to the Engineer's digital data files shall execute a data licensing agreement in the form of AIA Document C106 or Agreement included in this Project Manual or Agreement acceptable to the Employer and the Engineer.

C. PDF Document Preparation: Where PDFs are required to be submitted to the Engineer, prepare as follows:

1. Assemble complete submittal package into a single indexed file, incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
2. Name file with submittal number or other unique identifier, including revision identifier.
3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with a digital certificate on where indicated.

1.9 WEB-BASED PROJECT MANAGEMENT SOFTWARE

A. Web-based Project Management Software Package: Provide, administer, and use Web-based Project Management software package for purposes of hosting and managing project communication and documentation until Final Completion.

1. Web-based Project management software includes, at a minimum, the following features:

a. Compilation of Project data, including Contractor, subcontractors, Engineer, Employer, and other entities involved in Project. Include names of individuals and contact information.
b. Access control for each entity for each workflow process, to determine entity's digital rights to create, modify, view, and print documents.
c. Document workflow planning, allowing customization of workflow between project entities.
d. Creation, logging, tracking, and notification for Project communications required in other Specification Sections, including, but not limited to, RFIs, submittals, Minor Changes in the Work, Construction Change Directives, and Change Orders.
e. Track status of each Project communication in real time, and log time and date when responses are provided.
f. Procedures for handling PDFs or similar file formats, allowing markups by each entity. Provide security features to lock markups against changes once submitted.
g. Processing and tracking of payment applications.
h. Processing and tracking of contract modifications.
i. Creating and distributing meeting minutes.
j. Document management for Drawings, Specifications, and coordination drawings, including revision control.
k. Management of construction progress photographs.
l. Mobile device compatibility, including smartphones and tablets.

2. Provide up to seven (7) Project management software user licenses for use of the Engineer and the Employer, Construction Manager. Provide eight (8) hours of software training at Employer’s office for web-based Project software users.
3. At completion of the Project, provide a complete digital archive of all [BIM,] engineering, communication, coordination, and project records / data in a format readable by common desktop software applications and acceptable to the Engineer / Employer. Submit the archive to the Employer and the Engineer as complete archive copy(ies) on a digital storage medium / format acceptable to the Engineer and provide the data in a locked (read-only) format to prevent further changes.

B. All communications done using the Employer’s authorized electronic platform shall be considered as official communications and shall be recognized as officially certified documents issued by the submitting party.

1. The Employer will provide all authorized personnel the required Credentials and Licenses to access any designated systems.

2. The Web-based Project Management platform Configuration and Access will be administered by the Employer in accordance with the communications protocols of the Contract, and strictly subject to Change Management Controls.
3. The Web-based Project Management and any designated platforms not mentioned here are the proprietary property of the Employer, and should be managed in accordance to the Employer's Security Policies and Practices.
4. All Authorized personnel shall use their individually assigned credentials and accounts to login and access the designated systems in accordance with the Employer's Security Policies and Practices.
5. All Stakeholder granted access to any platform shall be subject to a License Terms & Conditions Agreement in an acceptable format as proposed by the Engineer and Employer.

C. To facilitate the inspection process, the Contractor may be requested to utilize the Project Collaboration Website (PCW) adopted by the Engineer, or any other solution provided by the employer, for the Inspection activities. It is an online information system intended to facilitate project communication, streamlining and tracking of the project correspondence. The PCW is a property of the Engineer, it shall be accessible through the internet browser and secured as per the Engineers security policies and practices. The Contractor's authorized personnel shall use their assigned credentials to login and access the website at no cost to the Contractor. The PCW solution is mainly based on the Microsoft Office SharePoint Server platform.

D. Contractor, Subcontractors, and other parties granted access by the Contractor to Engineer's Web-based Project Management shall execute a data licensing agreement in the form of an Agreement acceptable to the Employer and the Engineer.

E. PDF Document Preparation: Where PDFs are required to be submitted to Engineer, prepare as follows:

1. Assemble complete submittal package into a single indexed file, incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
2. Name file with submittal number or other unique identifier, including revision identifier.
3. Certifications: Where digitally submitted certificates and certifications are required, provide a digital signature with digital certificate on where indicated.

1.10 COMMON DATA ENVIRONMENT (CDE)

A. Provide, administer, and use Common Data Environment (CDE) for the purpose of hosting and managing the project [BIM &] Design deliverables, Coordination, and Documentation during Construction, As-Built and handover phases.

1. All CDE platform Configuration and Access will be administered by the Employer in accordance with the communications protocols of the Contract, and strictly subject to Change Management Controls.
2. The CDE and any designated platforms not mentioned here are the proprietary property of the Employer, and should be managed in accordance to the Employer's Security Policies and Practices.
3. Employer's CDE will host only Shared, Published and Archived information in accordance with the BS EN ISO 19650 Guidance Part C.
4. At the closeout stage of each Project a complete archive of all BIM, Engineering, Communication and Coordination Data shall be available in the CDE platform in accordance with the Employer's requirements.
5. The Contractor must establish their own CDE for managing the Project Documentation and Communication during the Design, Construction, As-Built and Handover stages.
6. The aforementioned CDE shall be fully complied with the processes and standards defined in ISO 19650 series and fully integrated with the existing Employer's PIMS & CDE eco-system in coordination with the Engineer.
7. The Contractor is required to align their CDE structure and System to that of the Employer's CDE.

8. The Contractor is required to advise the Engineer on their particular requirements in the Employer's CDE ensuring correct change management procedures are followed subject to Engineer and Employer's approval.
9. The Contractor remains solely responsible to retain all logical Relationships, Structures and Configurations so as to reproduce the original plot at any time from the source in their own, and Employer's CDE.
10. The Contractor is required to supervise their direct and Sub-Contracted works, in accordance with section 013300 and its Annexes. It will be the Contractor's responsibility to oversee and ensure all related information is shared to stakeholders with correct suitability and required Metadata which approved by the Engineer and Employer. All coordination and Collaboration shall occur in the Designated CDE.
11. The Contractor's CDE should be in accordance to the Employer's Security Policies and Practices.
12. The Contractor is required to coordinate information exchanges flawlessly / uninterrupted.

1.11 PROJECT MEETINGS

A. General: Schedule and conduct meetings and conferences at Project site unless otherwise indicated.

1. Attendees: Inform participants and others involved, and individuals whose presence is required, of date and time of each meeting. Notify the Employer and the Engineer of scheduled meeting dates and times a minimum of seven (7) days prior to meeting.
2. Agenda: Prepare the meeting agenda. Distribute the agenda to all invited attendees.
3. Minutes: Entity responsible for conducting meetings will record significant discussions and agreements achieved. Distribute the meeting minutes to everyone concerned, including the Employer, Construction Manager,] and the Engineer, within three (3) days of the meeting.

B. Preconstruction Conference: the Engineer will schedule and conduct a preconstruction conference before starting construction, at a time convenient to the Employer and the Engineer, but no later than fifteen (15) days after execution of the Agreement.
1. Attendees: Authorized representatives of the Employer, the Employer's Commissioning Authority, Construction Manager, the Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with the Project and authorized to conclude matters relating to the Work.
2. Agenda: Discuss items of significance that could affect progress, including the following:

a. Responsibilities and personnel assignments.
b. Tentative construction schedule.
c. Phasing.
d. Critical work sequencing and long lead items.
e. Designation of key personnel and their duties.
f. Lines of communications.
g. Use of web-based Project software.
h. Procedures for processing field decisions and Change Orders.
i. Procedures for RFIs.
j. Procedures for testing and inspecting.
k. Procedures for processing Applications for Payment.
l. Distribution of the Contract Documents.
m. Submittal procedures.
n. Sustainable design requirements.
o. Preparation of Record Documents.
p. Use of the premises and existing building.
q. Work restrictions.
r. Working hours.
s. Employer's occupancy requirements.
t. Responsibility for temporary facilities and controls.
u. Procedures for moisture and mold control.

v. Procedures for disruptions and shutdowns.
w. Construction waste management and recycling.
x. Parking availability.
y. Office, work, and storage areas.
z. Equipment deliveries and priorities.
aa. First aid.
bb. Security.
cc. Progress cleaning.
dd. Safety & Health
ee. [BIM Submittals].

3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.

C. BIM Coordination Conference: A BIM coordination conference shall be scheduled before starting construction, at a time convenient to Employer, Engineer, and Contractor, and then conducted at a biweekly interval throughout the duration of the contract.

1. Attendees: Authorized representatives of Employer, Engineer and Contractor and its superintendent and BIM coordinators; designers, major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with the Project and authorized to conclude matters relating to the Works.
2. Agenda: Discuss items of significance in relation to the BIM requirements, including the following:

a. BIM Execution Plan.
b. BIM Model status and review
c. BIM deliverables
d. Clash report and resolutions
e. [4D animations and simulations showing actual versus planned construction sequences
f. 5D cost analysis
g. BIM interface coordination between the different Contractors and the Engineer
h. Role of BIM coordinators/managers.

3. Minutes: The Engineer will record and distribute meeting minutes.

D. Sustainable Design Requirements Coordination Conference: Employer will schedule and conduct] [Construction Manager will schedule and conduct] a sustainable design coordination conference before starting construction, at a time convenient to the Employer's Representative, the Engineer, and Contractor.

1. Attendees: Authorized representatives of the Employer, the Engineer, and their consultants; Contractor and its superintendent and sustainable design coordinator; major subcontractors; suppliers; and other concerned parties shall attend the conference. Participants at the conference shall be familiar with the project and authorized to conclude matters relating to the Work.
2. Agenda: Discuss items of significance that could affect meeting sustainable design requirements, including the following:

a. Sustainable design Project checklist.
b. General requirements for sustainable design-related procurement and documentation.
c. Project closeout requirements and sustainable design certification procedures.
d. Role of sustainable design coordinator.
e. Construction waste management.
f. Construction operations and sustainable design requirements and restrictions.

3. Minutes: Entity responsible for conducting meeting will record and distribute meeting minutes.

E. Preinstallation Conferences: Conduct a preinstallation conference at the Project site before each construction activity when required by other Sections and when required for coordination with other construction.

1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting. Advise the Engineer, Construction Manager, and the Employer's Commissioning Authority of scheduled meeting dates.
2. Agenda: Review progress of other construction activities and preparations for the particular activity under consideration, including requirements for the following:

    a. Contract Documents.
    b. Options.
    c. Related RFIs.
    d. Related Change Orders.
    e. Purchases.
    f. Deliveries.
    g. Submittals.
    h. Sustainable design requirements.
    i. Review of mockups.
    j. Possible conflicts.
    k. Compatibility requirements.
    l. Time schedules.
    m. Weather limitations.
    n. Manufacturer's written instructions.
    o. Warranty requirements.
    p. Compatibility of materials.
    q. Acceptability of substrates.
    r. Temporary facilities and controls.
    s. Space and access limitations.
    t. Regulations of authorities having jurisdiction.
    u. Testing and inspecting requirements.
    v. Installation procedures.
    w. Coordination with other work.
    x. Required performance results.
    y. Protection of adjacent work.
    z. Protection of construction and personnel.
    aa. Health & Safety.
    bb. Security

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
4. Reporting: Distribute minutes of the meeting to each party present and to other parties requiring information.
5. Do not proceed with installation if the conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to the performance of the Work and reconvene the conference at earliest feasible date.

F. Project Closeout Conference: The Engineer will conduct a project closeout conference, at a time convenient to the Employer and the Engineer, but no later than ninety (90) days prior to the scheduled date of Substantial Completion.

1. Conduct the conference to review requirements and responsibilities related to Project closeout.
2. Attendees: Authorized representatives of the Employer, the Employer's Commissioning Authority, the Engineer, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the meeting. Participants

at the meeting shall be familiar with the Project and authorized to conclude matters relating to the Work.

3. Agenda: Discuss items of significance that could affect or delay Project closeout, including the following:

    a. Preparation of Record Documents.
    b. Preparation of As-Built Documents and BIM Model.
    c. Close-out / Handover procedure.
    d. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance.
    e. Procedures for completing and archiving web-based Project software site data files.
    f. Submittal of written warranties.
    g. Requirements for completing sustainable design documentation.
    h. Requirements for preparing operations and maintenance data.
    i. Requirements for delivery of material samples, attic stock, and spare parts.
    j. Requirements for demonstration and training.
    k. Preparation of Contractor's punch list.
    l. Procedures for processing Applications for Payment at Substantial Completion and for final payment.
    m. Submittal procedures.
    n. Coordination of separate contracts.
    o. The Employer's partial occupancy requirements.
    p. Installation of the Employer's furniture, fixtures, and equipment.
    q. Responsibility for removing temporary facilities and controls.

4. Minutes: Entity conducting meeting will record and distribute meeting minutes.

G. Progress Meetings: The Engineer will conduct progress meetings at weekly or fortnightly intervals; or more frequently whenever he considers it to be necessary.

1. Coordinate dates of meetings with preparation of payment requests.
2. Attendees: In addition to representatives of the Employer , the Employer's Commissioning Authority, Construction Manager, and the Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meeting shall be familiar with the Project and authorized to conclude matters relating to the Work.
3. Agenda: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

    a. Contractor's Construction Schedule: Review progress since the last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

4. Review schedule for next period.

    a. Review present and future needs of each entity present, including the following:

        1) Interface requirements.
        2) Sequence of operations.
        3) Status of submittals.
        4) Status of sustainable design documentation.
        5) Deliveries.
        6) Off-site fabrication.
        7) Access.

8) Site use.
9) Temporary facilities and controls.
10) Progress cleaning.
11) Quality and work standards.
12) Status of correction of deficient items.
13) Field observations.
14) Status of RFIs.
15) Status of Proposal Requests.
16) Pending changes.
17) Status of Change Orders.
18) Pending claims and disputes.
19) Documentation of information for payment requests.
20) BIM Performance & BIM Model progression.
21) Reviewing federated BIM Model NWD and any clashes.

4. Minutes: Entity responsible for conducting the meeting will record and distribute the meeting minutes to each party present and to parties requiring information.

    a. Schedule Updating: Revise Contractor's construction schedule after each progress meeting, where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

5. Reporting: The Engineer will record, prepare and distribute minutes of the meeting to each party present and to the Employer, together with a brief report summary in narrative form, of progress, actions required and other significant matters arising since the previous meeting and report.

H. Coordination Meetings: Conduct Project coordination meetings at weekly. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.

1. Attendees: In addition to representatives of the Employer, the Engineer, each contractor, subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings. All participants at the meetings should be familiar with Project and authorized to conclude matters relating to the Work.

2. Coordination Meetings: Attend Combined Contractor’s Meetings with other separate contractors or entities working as and when required by the Engineer. The meetings will be arranged and conducted by the Engineer for coordinating and sequencing purposes, and negotiating and agreeing delivery schedules, programs of work and interfacing activities, as necessary.
3. Agenda: Review and correct or approve minutes of the previous coordination meeting. Review other items of significance that could affect progress. Include topics for discussion as appropriate to status of Project.

    a. Combined Contractor's Construction Schedule: Review progress since the last coordination meeting. Determine whether each contract is on time, ahead of schedule, or behind schedule, in relation to combined Contractor's construction schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
    b. Schedule Updating: Revise combined Contractor's construction schedule after each coordination meeting, where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
    c. Review present and future needs of each contractor present, including the following:

        1) Interface requirements.

2) Sequence of operations.
3) Status of submittals.
4) Deliveries.
5) Off-site fabrication.
6) Access.
7) Site use.
8) Temporary facilities and controls.
9) Work hours.
10) Hazards and risks.
11) Progress cleaning.
12) Quality and work standards.
13) Status of RFIs.
14) Proposal Requests.
15) Change Orders.
16) Pending changes.
17) Variations.
18) Sustainability requirements
19) BIM Performance & BIM Model progression.
20) Reviewing federated BIM Model NWD and any clashes.
21) Resolution of BIM component conflicts.

4. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.
5. Engineer will establish and chair a coordination Committee to ensure absolute coordination on all aspects of this Contract. Engineer will schedule and conduct Project coordination meetings at regular intervals, or whenever he considers it to be necessary. Project coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and pre-installation conferences.

    a. Engineer at his absolute discretion will determine the following:

        1) Committee members and representatives.
        2) Location and Frequency.
        3) Procedures and processes to be followed in the meetings.
        4) Actions and activities instigated by the meetings.

    b. The Committee and meetings will be a forum to table and resolve any co-ordination or co-ordination related matters. It is the Engineer's intention to resolve these issues by mutual agreement between the parties, however, should this not be possible the Engineer will make a determination on the issue, and it will become formal and contractually binding on the Contractor or other concerned contractor as the case may be.
    c. Contractor must identify a senior individual or individual to attend co-ordination meetings and act as a point of contact on all co-ordination issues. These individuals must be approved in writing by the Engineer who also has the right to remove them and have them replaced by further approved individuals at his discretion.
    d. It is noted that these meetings are in addition to other project meetings which will be occurring and that the determination from these higher level co-ordination meetings must manifest themselves into a series of further lower-level meetings to implement and ensure the practical application of co-ordination throughout the project. It is incumbent upon the Contractor to demonstrate to the satisfaction of the Engineer how co-ordination is actually being achieved on site.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013100

SECTION 013200 - CONSTRUCTION PROGRESS DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions, and other Division 01 Specifications sections, apply to this Section.

1. Refer to Conditions of Contract and Agreement for definitions and specific dates of Contract Time.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including the following:

1. Startup construction schedule.
2. Contractor's Construction Schedule.
3. Construction schedule updating reports.
4. Daily construction reports.
5. Material location reports.
6. Field condition reports.
7. Unusual event reports.
8. Submittals Schedule.
9. Monthly progress reports
10. Accident reports
11. Wage book and time sheet records.
12. Special reports.
13. Inspection test Procedures Report.
14. Variations requests.

B. Related Requirements:

1. Division 01 Section 011000 "Summary" for Work sequence and staged completion and occupation requirements.
2. Division 01 Section 011200 "Multiple Contract Summary" for preparing a combined Contractor's Construction Schedule.
3. Division 01 Section 013100 "Project Management and Coordination" for distributing meeting and conference minutes
4. Division 01 Section 013300 "Submittal Procedures" for submitting schedules and reports.
5. Division 01 Section 014000 "Quality Requirements" for submitting a schedule of tests and inspections.
6. Specifications sections for specific submittal requirements.

1.3 DEFINITIONS

A. Activity: A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction Project. Activities included in a construction schedule consume time and resources.

1. Critical Activity: An activity on the critical path that must start and finish on the planned early start and finish times.

2. Predecessor Activity: An activity that precedes another activity in the network.
3. Successor Activity: An activity that follows another activity in the network.

B. Cost Loading: The allocation of the schedule of values for completing an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum unless otherwise approved by the Engineer.

C. CPM: Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine the critical path of the Project and when activities can be performed.

D. Critical Path: The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project duration and contains no float.

E. Event: The starting or ending point of an activity.

F. Float: The measure of leeway in starting and completing an activity.

1. Float time is not for the exclusive use or benefit of either Employer or Contractor, but is a jointly owned, expiring Project resource available to both parties as needed to meet schedule milestones and Contract completion date.
2. Free float is the amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
3. Total float is the measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.

G. Resource Loading: The allocation of manpower and equipment necessary for completing an activity as scheduled.

H. Network Diagram: A graphic diagram of a network schedule, showing activities and activity relationships

I. Fragnet: A partial or fragmentary network that breaks down activities into smaller activities for greater detail.

J. Major Area: A work area or storey of construction as applicable, a separate building as applicable, or a similar significant construction element.

K. Milestone: A key or critical point in time for reference or measurement, including for example, but not necessarily limited to:

1. Commencement Date.
2. Completion dates for specific Sections or parts of the Works.
3. Completion date for the whole of the Works.

L. Preliminary Construction Schedule: Startup Construction Schedule.

1.4 INFORMATIONAL SUBMITTALS

A. Format for Submittals: Submit required submittals in the following format:

1. Working electronic copy of schedule file and its layout displaying the required columns for the entire period.
2. PDF file.
3. [Three (3)] paper copies of sufficient size to display entire period or schedule, as required.
4. Arrange the following information in a tabular format, identifying corresponding program activity or event number for each scheduled date:

a. Scheduled date for first submittal.
b. Specification Part number and title.
c. Submittal type and category (action or informational).
d. Name of manufacturer and/or subcontractor, as applicable.
e. Description of the work covered.
f. Scheduled date for the Engineer's final release or approval.
g. Scheduled dates for Purchase Order and first delivery to Project site.
h. Scheduled date for commencement of installation.

B. Startup construction schedule.

1. Submittal of cost-loaded startup construction schedule will not constitute approval of schedule of values for cost-loaded activities.

C. Startup Network Diagram: Of size required to display entire network for entire construction period. Show logic ties for activities.

D. Contractor's Construction Schedule: Initial schedule, of size required to display entire schedule for entire construction period.
1. Submit a working digital copy of schedule, using software indicated, and labeled to comply with requirements for submittals.

E. CPM Reports: Concurrent with CPM schedule, submit each of the following reports. Format for each activity in reports shall contain activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.

1. Activity Report: List of activities sorted by activity number and then early start date, or actual start date if known.
2. Logic Report: List of preceding and succeeding activities for each activity, sorted in ascending order by activity number and then by early start date, or actual start date if known.
3. Total Float Report: List of activities sorted in ascending order of total float.
4. Earnings Report: Compilation of Contractor's total earnings from commencement of the Work until most recent Application for Payment.
5. Resource Allocation and Loading Report: List of all resources allocated to schedule activities, sorted in ascending order by activity number and then early start date, or actual start date if known, including but not necessarily limited to:
6. Number and trade classification of workmen.
7. Quantities of materials and products.
8. Contractor's Equipment.
9. Monetary Value Summaries (cash flow).

F. Construction Schedule Updating Reports: Submit with Applications for Payment.

G. Daily Construction Reports: Submit at daily interval, and no later than 4:00 pm on the day immediately following date of report.

H. Sub-contractor's daily report: Submit at daily interval and no later than 4:00 pm on the day immediately following date of report.

I. Material Location Reports: Submit at [**weekly**] [**monthly**] intervals.

J. Site Condition Reports: Submit at time of discovery of differing conditions.

K. Accident Reports: Submit at time of accident report.

L. Unusual Event Reports: Submit at time of unusual event.

M. Monthly Progress Reports: Submit at monthly intervals. Report progress status coincidental with cut-off date associated with each Monthly Statement payment application.

1.5 QUALITY ASSURANCE

A. Scheduling Specialist Consultant Qualifications: An experienced specialist in CPM scheduling and reporting, with capability of producing CPM reports and diagrams within 24 hours of the Engineer's request.

B. Prescheduling Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to the preliminary construction schedule and Contractor's Construction Schedule, including, but not limited to, the following:

1. Review software limitations and content and format for reports.
2. Verify availability of qualified personnel needed to develop and update schedule.
3. Discuss constraints, including phasing, work stages, area separations, interim milestones and partial Employer occupancy (where applicable).
4. Review delivery dates for the Employer-furnished products.
5. Review schedule for work of the Employer's separate contracts (if applicable).
6. Review submittal requirements and procedures.
7. Review time required for review of submittals and resubmittals.
8. Review requirements for tests and inspections by independent testing and inspecting agencies.
9. Review time required for Project completion and startup procedures.
10. Review and finalize list of construction activities to be included in schedule.
11. Review procedures for updating schedule.

1.6 COORDINATION

A. Coordinate the preparation and processing of schedules and reports with performance of construction activities and with programming scheduling and reporting of separate contractors.

B. Utilization of 4D Planning and Scheduling: The Contractor shall utilize 4D methods to develop and / or update the Project BIM Model(s) with the approved [Design and] Construction Program. The 4D Model shall be used to perform “Planned versus Actual” analysis and to demonstrate construction sequencing, phasing, and progress, as detailed in Section 013300 and its Annexes. Where applicable, and depending on the contract type, the Contractor shall incorporate both Design and Construction BIM Models into this process.

C. Utilization of 5D Cost analysis: The Contractor shall utilize 5D methods to extract and validate material quantities from the Project BIM Model(s), and integrate them with the approved Construction Program and cost data (BOQ, estimates, and / or payment items). The 5D Model shall be used to monitor the Construction progress, evaluate cost performance, and support reporting requirements, as detailed in Section 013300 and its Annexes. Where applicable, and depending on the contract type, the Contractor shall incorporate both Design and Construction BIM Models into this process.

D. Coordinate Contractor's Construction Schedule/program with the list of subcontracts**,** submittal schedule, progress reports, payment requests, and other required schedules and reports.

1. Secure time commitments for performing critical elements of the Work from entities involved.
2. Coordinate each construction activity in the network with other activities, and schedule them in proper sequence.

1.7 CONTRACTOR'S CONSTRUCTION SCHEDULE

A. Computer Scheduling Software: Prepare and update schedules using current version of a program that is capable of managing construction schedules.

1. Use a professional high-end, reputable Project Management software (Oracle Primavera P6 Professional, latest edition) that has been developed specifically to manage construction programming, scheduling and reporting indicated for Project.
2. Provide two (2) user licenses for use of the Employer and the Engineer.
3. Provide eight (8) hours of software training at the Engineer / Employer's office for software users.

B. Scheduling Consultant: Engage a consultant to provide planning, evaluation, and reporting, using CPM scheduling.

1. In-House Option: The Employer may waive requirement to retain a consultant if Contractor employs skilled personnel with experience in CPM scheduling and reporting techniques. Submit qualifications.
2. Meetings: Scheduling consultant shall attend all meetings related to Project progress, alleged delays, and time impact.

C. Time Frame: Extend schedule from date established for commencement of the Work, To Proceed to date of Final Completion.

1. Contract completion date shall not be changed by submission of a schedule that shows an early completion date, unless specifically authorized by Variation Order.

D. Calendar and Working Hours:

1. The normal working hours shall be in accordance with the labor laws of the country where the project is being executed. Any changes or exceptions to the working hours and official holidays must be approved by the Engineer and the Employer.
2. The Employer / Engineer or others with delegated authority shall approve the starting and finishing times, lunch and tea breaks of the dayshift proposed by the Contractor.
3. The Contractor is allowed, subject to the prior approval of the Employer / Engineer or others with delegated authority to work in multiple shifts as necessary to meet the construction schedule. Contractor to bear any additional cost due to this requirement.
4. The Contractor shall note that staggered work hours may be required to be adopted to ease congestion on the site, access road routes, security gates, and elsewhere on the Site or to avoid inconvenience to the existing neighbouring contractors, tenants and public as applicable.

E. Work Breakdown Structure (WBS):

1. The Work Breakdown Structure WBS, WBS dictionary and levels shall be prepared and developed by the Contractor in consultation with the Engineer and the Employer. This will help establishing a mapping of the codes in the Baseline schedule and its integration and provides consistency across all designer, contactor and subcontractor schedules, across all projects. It may be necessary to develop the WBS further as the project progresses, and as the Construction Program is developed. Any additions to the WBS will be proposed by the Contractor in writing and approved by the Engineer and the Employer.

F. Activities: Treat each floor or separate area as a separate numbered activity for each main element of the Work. Comply with the following:

1. Activity ID Numbering: Each activity should have a unique alphanumerical identifier which would be set together with the Engineer for consistency purpose and application in all Program of works.

2. Activity Duration: Define activities so no activity is longer than twenty (20) days, unless specifically allowed by the Engineer (i.e. procurement of materials especially long lead items).
3. Activity Lag Duration: Replace the lag duration with an activity if possible or justify the use of the lag that is longer than twenty (20) days, unless specifically allowed by the Engineer.
4. BIM Activities: Define the BIM activities and include the BIM models [and design], Shop and As-built drawings schedules within the [design and] construction program.
5. Temporary Facilities: Indicate start and completion dates for the following as applicable:

    a. Securing of approvals and permits required for performance of the Work.
    b. Temporary facilities.
    c. Construction of mock-ups, prototypes and samples.
    d. The Employer interfaces and furnishing of items.
    e. Interfaces with Separate Contracts.
    f. Regulatory agency approvals.
    g. Punch list.

6. Procurement Activities: Include procurement process activities for the following long lead-time items and major items, requiring a cycle of more than 60 days, as separate activities in schedule. Procurement cycle activities include, but are not limited to, submittals, approvals, purchasing, fabrication, and delivery.

7. Submittal Review Time: Include review and resubmittal times indicated in Section 013300 "Submittal Procedures" in schedule. Coordinate submittal review times in Contractor's Construction Schedule with submittal schedule.
8. Startup and Testing Time: Include no fewer than fifteen (15) days for startup and testing.
9. Commissioning Time: Include no fewer than fifteen (15) days for commissioning.
10. Substantial Completion: Indicate completion in advance of date established for Substantial Completion and allow time for the Engineer’s and Construction Manager's administrative procedures necessary for certification of Substantial Completion.
11. Punch List and Final Completion: Include not more than thirty (30) days for completion of punch list items and Final Completion.

G. Constraints: Include constraints and work restrictions indicated in the Contract Documents and as follows in schedule and show how the sequence of the Work is affected.

1. Phasing: Arrange list of activities on schedule by phase.
2. Work under More Than One Contract: Include a separate activity for each contract.
3. Work by the Employer: Include a separate activity for each portion of the Work performed by the Employer.
4. Products Ordered in Advance: Include a separate activity for each product. Include delivery date indicated in Section 011000 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
5. The Employer-Furnished Products: Include a separate activity for each product. Include delivery date indicated in Section 011000 "Summary." Delivery dates indicated stipulate the earliest possible delivery date.
6. Work Restrictions: Show the effect of the following items on the schedule:

    a. Coordination with existing construction.
    b. Limitations of continued occupancies.
    c. Uninterruptible services.
    d. Partial occupancy before Substantial Completion.
    e. Use-of-premises restrictions.
    f. Provisions for future construction.
    g. Seasonal variations.
    h. Environmental control.

7. Work Stages: Indicate important stages of construction for each major portion of the Work, including, but not limited to, the following:

a. Subcontract awards.
b. Submittals.
c. Purchases.
d. Mockups.
e. Fabrication.
f. Sample testing.
g. Deliveries.
h. Installation.
i. Tests and inspections.
j. Adjusting.
k. Curing.
l. Building flush-out.
m. Startup and placement into final use and operation.
n. Commissioning.

8. Construction Areas: Identify each major area of construction for each major portion of the Work. Indicate where each construction activity within a major area must be sequenced or integrated with other construction activities to provide for the following:

a. Structural completion.
b. Temporary enclosure and space conditioning.
c. Permanent space enclosure.
d. Completion of mechanical installation.
e. Completion of electrical installation.
f. Substantial Completion.

H. Sectional Completions and Milestones: Include in program, milestones and any and all sectional completion requirements, indicated in Contract Documents, including but not necessarily limited to Commencement Date, dates for Substantial Completion sections or parts of the Works, and date for Substantial Completion the whole of the Works, and any other milestone specified in the Conditions of Contract.

I. Milestones: Include milestones indicated in the Contract Documents in schedule, including, but not limited to, the Notice to Proceed, Substantial Completion and any interim milestones.

J. Cost Correlation: Superimpose a cost correlation timeline, indicating planned and actual costs. On the line, show planned and actual Monetary volume of the Work performed as of planned and actual dates used for preparation of payment requests.

K. Upcoming Work Summary: Prepare summary report indicating activities scheduled to occur or commence prior to submittal of next schedule update. Summarize the following issues:

1. Unresolved issues.
2. Unanswered Requests for Information.
3. Rejected or unreturned submittals.
4. Notations on returned submittals.
5. Pending modifications affecting the Work and the Contract Time.

L. Cash Flow Correlation: Provide a cash flow correlation line, indicating on the line, monetary value volume of the Works as planned and as actually performed.

M. Tabulate cash flow correlation, coincidental with cutoff dates associated with Monthly Statement payment applications and use as a basis for preparation of Cash Flow Estimate submittal.

N. Contract Variations: If and when requested by the Engineer in connection with any proposed or instructed contract Variation, prepare and submit a time-impact analysis, using fragnets if necessary, to demonstrate the effect of the proposed or instructed Variation on the overall program.

O. Contractor's Construction Schedule Updating: At monthly intervals, update schedule to reflect actual construction progress and activities. Issue schedule one week before each regularly scheduled progress meeting.

1. The Contractor shall organize a joint progress measurement and inspection with the Engineer to verify the actual start/finish dates and completed percentage of each activity in the Baseline Schedule and shall be updated in Primavera P6 latest released version every week or at any other frequency required by the Engineer.
2. Revise the program immediately after each meeting or other activity where revisions have been recognized and accepted by the Engineer. Issue and submit the revised program within three (3) days of such meetings or activities. Include a report with the revised program that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
3. For completed Activities – Enter Actual Start and Actual Finish Dates, Actual Quantities and Actual Expenses.
4. For Activities in progress – Update Actual Start Dates, Forecast Completion Dates, Expense %, Actual Quantities, Actual Resources and Physical %.
5. Actual Physical Progress for activity should be equal to Expenses %.
6. Expense (Cost) Update – update % complete (as approved by the Engineer) for each Cost Account for activities. This information will be used for generating Contractor's Progress Payment Request.
7. Include a report with the updated schedule that indicates every change, including, but not limited to, changes in logic, durations, actual starts and finishes, and activity durations.
8. Each Updated Schedule shall be submitted to the Engineer for its acceptance as a record. It is possible (if the works have been delayed) that these Updated Schedules will show completion later than the contract completion dates. In this event the Engineer's acceptance of such schedules will not constitute acceptance of the delay(s).
9. The Contractor is deemed to provide the Engineer with detailed pricing and breakdowns of all activities (if required) for the updating purposes. Any missing information/details shall be as per the interpretation of the Engineer.

P. Revision and Extension of Time: Once the Engineer gives the consent on the Baseline the Contractor shall not revise the Activity Duration(s) or Network Logic of the Baseline Schedule without written approval.

Q. The Baseline Schedule may be changed and / or an Extension of Time may be granted when one or more of the following occurs and shall be reviewed and approved by the Engineer:

R. A Variation Order that significantly affects the duration/dates of completion or sequence of work and construction methodology.

S. The Engineer or the Employer (or Change Board, whichever applies) directs in writing a change that affects the milestone date(s) specified in the Contract and/or alters the length of the critical path

T. In the event of occurrence of one of the above, the Contractor may submit a request for Extension of Time and/or Revision of the Project Work Schedule. The submittal shall indicate changes required to the Contract completion date, proposed revised logic network and shall be accompanied by a narrative description and justification for the change.

U. Once consented the revised schedule shall be used as the Revised Baseline Schedule and the updates thereafter will be based on this aforementioned schedule.

V. Recovery Schedule:

1. When periodic update indicates the Work is twenty-one (21) or more calendar days behind the current approved schedule, meaning in the event of substantial schedule slippage or out of sequence of works relative to the consented Baseline Schedule, submit when necessary and as required by the Engineer, a separate recovery schedule indicating means by which Contractor intends to regain compliance with the schedule. The Recovery Schedule shall

identify which activities and milestones that are affected and demonstrate how the Contractor plans to recover his present delays and shall also indicate changes to working hours, working days, crew sizes, and equipment required to achieve compliance, and date by which recovery will be accomplished.

2. Recovery Schedule shall be strictly for the purpose of demonstrating to the Engineer how the Contractor plans to bring progress back to that projected in the consented Baseline Schedule. It shall also serve to allow the Engineer to monitor the Progress of the Contractor's recovery plan.
3. As the Recovery Schedule does not constitute an accepted revised baseline, the Contractor shall continue to report his progress against the consented baseline schedule. The Contractor shall also update the Engineer on the progress of his recovery against the recovery schedule.
4. As the Work progresses, indicate Final Completion percentage for each activity.

W. Distribution: Distribute copies of approved schedule to the Engineer , Construction Manager, the Employer, separate contractors, testing and inspecting agencies, and other parties identified by Contractor with a need-to-know schedule responsibility.

1. Post copies in Project meeting rooms and temporary field offices.
2. When revisions are made, distribute updated schedules to the same parties and post in the same locations. Delete parties from distribution when they have completed their assigned portion of the Work and are no longer involved in performance of construction activities.

X. As-Built Schedule and documentation:

1. Within fifteen (15) days after substantial completion, the Contractor shall submit for the Project's acceptance a final, as-built CPM Network Diagram.

1.8 STARTUP CONSTRUCTION SCHEDULE

A. Gantt-Chart Schedule: Submit startup, horizontal, Gantt-chart-type construction schedule within seven (7) days of date established for commencement of the Work.

B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line. Outline significant construction activities for first ninety (90) days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

1.9 GANTT-CHART SCHEDULE REQUIREMENTS

A. Gantt-Chart Schedule: Submit a comprehensive, fully developed, horizontal, Gantt-chart-type, Contractor's Construction Schedule within thirty (30) days of date established for commencement of the Work.

1. Base schedule on the startup construction schedule and additional information received since the start of Project.

B. Preparation: Indicate each significant construction activity separately. Identify first workday of each week with a continuous vertical line.

1. For construction activities that require three months or longer to complete, indicate an estimated completion percentage in ten (10) percent increments within time bar.

1.10 CPM SCHEDULE REQUIREMENTS

A. Prepare network diagrams using AON (activity-on-node) format.

B. Startup Network Diagram:

1. Submit diagram within fourteen 14 days of date established for commencement of the Work. Outline significant construction activities for the first ninety (90) days of construction. Include skeleton diagram for the remainder of the Work and a cash requirement prediction based on indicated activities.

C. CPM Schedule:

1. Prepare and submit a Contractor's Construction Schedule not later than thirty (30) calendar days after letter of award, using a CPM network analysis diagram. for the Work. Base program on the Preliminary Program submitted with Tender and whatever updating and feedback received to date. Follow procedures and produce CPM schedule and reports in such form and detail as specified. Incorporate additional requirements, as the Engineer shall reasonably prescribe.
2. Develop, finalize and submit completed CPM schedule and reports for the Engineer's review and consent no later than fifty-six (56) days after the Letter of Award, unless specified otherwise in the Particular Conditions of Contract.

    a. Failure to include any work item required for performance of this Contract shall not excuse Contractor from completing all work within applicable completion dates.

3. Conduct educational workshops to train and inform key Project personnel, including subcontractors' personnel, in proper methods of providing data and using CPM schedule information.
4. Once consented, this Baseline Schedule will be used as per the Contract Clause – Program. No changes to Baseline Schedule are allowed without complying to schedule revision requirements described in below section herein.
5. The consented schedule shall then be used by the Contractor for planning, organizing and directing the Works and for reporting progress payment.
6. Establish procedures for monitoring and updating CPM schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.
7. Use "one workday" as the unit of time for individual activities. Indicate nonworking days and holidays incorporated into the schedule to coordinate with the Contract Time.
8. Use calendar to identify and indicate holidays and other non-work days

D. CPM Schedule Preparation:

1. Prepare a list of all activities required to complete the Work. Using the startup network diagram, prepare a skeleton network to identify probable critical paths.
2. Activities: indicate for each activity which shall comprise of specific and measurable element of work, the estimated time duration which will be calculated using productivity rates, sequence requirements, resource requirements and relationship of each activity in relation to other activities and monetary value. No activity on the project work schedule shall have the duration exceeding twenty-one (21) calendar days and number of activities with duration of less than Seven (7) calendar days should be kept to a minimum and excessive amount of float should be avoided / rectified to make progress monitoring on the project more manageable.
3. The activities on the schedule shall be in accordance with the Work Breakdown Structure (WBS), Cost Breakdown Structure (CBS), Resource Breakdown Structure (RBS) and Activity Codes. As a minimum Activities shall cover and include dates and estimated time frames for the following:

    a. Preparation and processing of submittals.
    b. Mobilization and securing of permits and Demobilization.
    c. Engineering (Submittals and Approval of shop drawings and documents).
    d. Procurement and Purchase of materials and equipment.
    e. Delivery.
    f. Fabrication.

g. Accurate definition for the Long Lead Items and their Material Requirement Plans (MRP).
h. Utility interruptions.
i. Any activities for other Contractors including but not limited to site possession and access and in which affect progress or completion date of all or part of the works.
j. Installation.
k. Work by the Employer that may affect or be affected by Contractor's activities.
l. Testing and inspection.
m. Commissioning.
n. Punch list and Final Completion.
o. Activities occurring following Final Completion.

4. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.
5. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the CPM schedule within the limitations of the Contract Time.
6. Format: Mark the critical path. Locate the critical path near center of network; locate paths with most float near the edges.

    a. Subnetworks on separate sheets are permissible for activities clearly off the critical path.

7. Logic Relationships:

    a. Logic of interdependencies shall be based on constructability and not on preferred working logic
    b. Float is an asset of the Project and NOT for the exclusive use/benefit of the Contractor
    c. Interference with all related packages should be clearly identified.

8. The schedule shall be prepared in sufficient detail (matching the method of handing over regarding zoning, flooring, trades, etc.) which would be discussed and agreed by the Engineer.to ensure adequate planning, execution and monitoring of the work.
9. The schedule shall consider all time risk allowances, including time for the weather conditions (rain, wind, etc.) reasonably to be anticipated by the Contractor.
10. Excessive leads and lags, negative lags or open/hanging activities, use of fixed dates and any other programming activities that can have the effect of creating false criticality or inhibiting the Schedule from reacting dynamically to change should be avoided.
11. Cost- and Resource-Loading of CPM Schedule:

    a. Resource loading: assign manpower, construction equipment and material quantities to activities. It should be reflected in the Resource Charts (Curve and Histogram)
    b. Cost loading: Assign monetary value / cost to construction activities on the CPM schedule as per the Contract Bill of Quantities, Unit Rates, Prices and Quantities (Expense Category on Primavera P6). Do not assign costs to submittal activities. Obtain Engineer's approval prior to assigning costs to fabrication and delivery activities
    c. Each activity cost shall reflect an appropriate value subject to approval by the Engineer.
    d. Total cost assigned to activities shall equal the total Contract Sum.

12. Submittal of CPM Detailed Construction Work schedule: to include but not limited to:

    a. Program Narrative and Method Statement highlighting the project constraints and assumptions made.
    b. Cost and Resource Loaded Baseline Schedule.
    c. Cash Flow Statement and Progress S-Curve.
    d. Resource Charts (distribution curve and histogram).

e. Others as required by the Engineer.

E. Contract Modifications: For each proposed contract modification and concurrent with its submission, prepare a time-impact analysis using a network fragment to demonstrate the effect of the proposed change on the overall Project schedule.

F. Initial Issue of Schedule: Prepare initial network diagram from a sorted activity list indicating straight "early start-total float." Identify critical activities. Prepare tabulated reports showing the following:

1. Contractor or subcontractor and the Work or activity.
2. Description of activity.
3. Main events of activity.
4. Immediately preceding and succeeding activities.
5. Early and late start dates.
6. Early and late finish dates.
7. Activity duration in workdays.
8. Calendar for each activity
9. Total float or slack time.
10. Average size of workforce.
11. Monetary value of activity (coordinated with the schedule of values).
12. Holidays and non-work days.
13. Schedule Updating: Concurrent with making updates and/or revisions to schedule, prepare (in addition to other specified CPM reports) tabulated reports showing the following:
14. Identification of activities that have changed.
15. Changes in early and late start dates.
16. Changes in early and late finish dates.
17. Changes in activity durations in workdays.
18. Changes in the critical path.
19. Changes in total float or slack time.
20. Changes in usage or availability of resources
21. Changes in the Contract Period.
22. Value Summaries: Prepare two cumulative value lists, sorted by finish dates. Indicate actual versus original planned progress.
23. Interface requirements, with prioritized completion of sections to achieve project hand-over in sequence as per the Employer’s requirements.
24. Coordination with other contractors.
25. Testing and commissioning of completed section considering continuity with other phases at interphase points.

G. Schedule Updating:

1. Updates shall consist of reflecting actual site data and implemented on the schedule to be consented by the Engineer without any changes or amendments or revisions whatsoever to the said schedule or activities or links therein. Any revisions to the schedule shall have to be submitted for the prior consent of the Engineer.
2. Concurrent with revising schedule, prepare tabulated reports showing the following:

a. Identification of activities that have changed.
b. Changes in early and late start dates.
c. Changes in early and late finish dates.
d. Changes in activity durations in workdays.
e. Changes in the critical path.
f. Changes in total float or slack time.
g. Changes in the Contract Time.

H. Value Summaries: Prepare two cumulative value lists, sorted by finish dates.

1. In first list, tabulate activity number, early finish date, Monetary value, and cumulative Monetary value.
2. In second list, tabulate activity number, late finish date, Monetary value, and cumulative Monetary value.
3. In subsequent issues of both lists, substitute actual finish dates for activities completed as of list date.
4. Prepare a list for ease of comparison with payment requests; coordinate timing with progress meetings.
5. In both value summary lists, tabulate "actual percent complete" and "cumulative value completed" with total at bottom.
6. Submit value summary printouts one week before each regularly scheduled progress meeting.

I. Execution Method Statement: Submit with the Contractor's Construction Program a method statement more detailed than that submitted with Tender, addressing all aspects of work and outlining the overall safety, health and environmental aspects, access, access to third parties, logistics, storage areas, security measures. The Method Statement shall be exhaustive and shall cover all major components of execution. Include in the Method Statement a description of the management and implementation methods for the engineering, procurement, transportation, installation, testing and commissioning of all major materials and equipment. Identify any specific coordination/interface requirements with other contractors' work. Give a description of all temporary construction requirements including detailed location of construction plant, equipment capacities, clearances, etc. supplemented by relevant sketches.

1.11 REPORTS AND DASHBOARDS

A. Daily Construction Reports: Prepare a daily construction report recording the following information concerning events at Project site:

1. List of subcontractors at Project site.
2. List of separate contractors at Project site.
3. Approximate count of personnel at Project site.
4. Equipment at Project site.
5. Material deliveries.
6. Weather record: High and low temperatures and general weather conditions, including presence of rain or snow.
7. Summary of completed activities for the previous day
8. Ongoing activities continuing today with the quantities achieved today and cumulatively
9. Activities started today
10. Activities scheduled for next day
11. Visitors Log
12. Testing and inspection.
13. Accidents log
14. Meetings and significant decisions.
15. Unusual events.
16. Stoppages, delays, shortages, and losses.
17. Meter readings and similar recordings.
18. Emergency procedures.
19. Orders and requests of authorities having jurisdiction.
20. Change Orders received and implemented.
21. Site Instructions received and implemented.
22. Services connected and disconnected.
23. Equipment or system tests and startups.
24. Partial completions and occupancies.
25. Substantial Completions authorized.
26. Problems encountered
27. Any other general or specific information requested by the Engineer to be reported.

B. Material Location Reports: At weekly intervals, prepare and submit a comprehensive list of materials delivered to and stored at Project site. List shall be cumulative, showing materials previously reported plus items recently delivered. Include with list a statement of progress on and delivery dates for materials or items of equipment fabricated or stored away from Project site. Indicate the following categories for stored materials:

1. Material stored prior to previous report and remaining in storage.
2. Material stored prior to previous report and since removed from storage and installed.
3. Material stored following previous report and remaining in storage.

C. Field Condition Reports: Immediately on discovery of a difference between site conditions and the Contract Documents, prepare and submit a detailed report. Submit with a Request for Information. Include a detailed description of the differing conditions, together with recommendations for changing the Contract Documents.

D. Accident Reports: On the occurrence of any accident which causes personal injury, or damage to the Works or any other property, prepare a detailed accident report and submit directly to Engineer within one day of occurrence. Include details of date and time, location, prevailing conditions, chain of events and causes leading up to accident, persons involved, response by Contractor's personnel and result or effect of accident. Obtain and attach witness statements, photographs and sketches as applicable.

1. On the occurrence of an accident or event which causes serious injury to any person, summon emergency services, notify appropriate authorities and inform Engineer immediately.

E. Project Risks: The Project Risks should be reported at the Project level on a monthly basis and should include at a minimum:

1. Risk Register

    a. Top 10 Risks (Scoring and Status).
    b. Top 10 Issues (Scoring and Status).

2. QSRA Results and required mitigation actions.

F. Unusual Event Reports: When an event of an unusual and significant nature occurs at Project site, whether or not related directly to the Work, prepare and submit a special report. List chain of events, persons participating, responses by Contractor's personnel, evaluation of results or effects, and similar pertinent information. Advise the Employer in advance when these events are known or predictable.

1. Submit unusual event reports directly to the Employer within **[one (1)]** day(s) of an occurrence. Distribute copies of report to parties affected by the occurrence.

G. Weekly Reports and Dashboards: The Contractor shall prepare weekly reports and dashboards, using excel spreadsheets and Power BI and submit to the Employer / Engineer or others with delegated authority on the designated day of each week as decided by the Employer / Engineer or others with delegated authority. Generally, the submission of weekly reports and dashboards shall be two days prior to the day of the progress meetings. The cut-off date of data date for this report shall be the Friday of the previous week. The weekly report shall consist as a minimum the following:

1. Updates of actual progress information.
2. Actual utilization of manpower.
3. Construction equipment.
4. Status of submissions.
5. Material procurement/delivery status.
6. Updated status and list of claims, variation orders and site instructions.
7. Safety record and statistics.

8. Quality Control statistics (i.e. Non-Conformance Report NCR, Request for Inspection RFI Report).
9. Weather record summary.
10. Update on problems encountered.
11. Other documents as required by the Engineer from time to time.

H. BIM Key performance Indicators (KPI's) and BIM Model progression matrix.

I. 4D & 5D simulations with relevant models.

J.]Monthly Progress Reports: Prepare and submit monthly progress reports, summarizing activities, achievements, advancements and significant events at Project site in month preceding, and reporting current progress status of Work; including but not necessarily limited to the following:

1. Executive Summary: detailing the planned versus actual progress, defining problem areas, risk items, anticipated delays and impact on the schedule. Provide delay analysis and the corrective action needed to recover the situation.
2. Summary of the information included in Daily Construction Reports for the month.
3. Summary of the information included in Material Location Reports for the month.
4. Latest update Submittals Schedule: Engineering Status, reports for Submittals overdue, held and rejected and Correspondence action log specially those requiring the Engineer's action or others. Same for Material procurement status.
5. Progress Review Statement: Refer to latest Update Contractor's Construction Program; include:

    a. Listing of all current month programmed activities and report whether each is on time, ahead of schedule or behind schedule in relation to original Contractor's Construction Program.
    b. On-going comparative line plot of Cash Flow Estimate against Interim Payment Certificates.
    c. Description of means, methods and actions to be taken in following month to expedite construction behind schedule and ensure current and subsequent activities will be completed within Time for Completion.

6. Status of Instructions/Information Requests: An updated list of RFI (Request for Information), NOV (Notice of Variation), EI (Engineer's Instruction), NCR (Non - Conformance Reports), indicating their status.
7. Updated Resource Charts (distribution curve and histogram).
8. Updated status and list of Claims, Variation Orders and Site Instructions/Memo.
9. Progress S-Curve (Planned/forecast against actual progress of works).
10. Primavera report showing activities planned for **[90]** days Look Ahead of Baseline Schedule, Updated Work Schedules and Recovery Schedule.
11. Primavera Report for Earned Value.
12. Primavera Schedule Reports for critical path, analysis and actions required to recover delay including updates on claims for Extension of Time submitted and approved.
13. Updated Manpower Loaded Schedule (including Histogram & 'S' curve): The Manpower Loaded Schedule included with the approved Schedule of Works shall be updated with actual expanded manpower and detailed with forecast manpower to be utilized. The Manpower Histogram shall be updated every week to compare and reflect the actual manpower at site. The histogram and 'S' curve shall show actual and forecast against planned.
14. Progress Photos: The Contractor shall note the requirements contained elsewhere in this Section.
15. Any other general or specific information, requested by the Engineer to be reported.

1.12 WAGE BOOK AND TIME SHEET RECORDS

A. Wage Books and Time Sheets: Keep and maintain accurate and proper wage books and time sheets of wages paid to and time worked by all workmen employed by Contractor and subcontractors at

Project site. Comply with regulations and requirements, if any, of authorities having jurisdiction. Store wage books and time sheets in field office and make available for Engineer's inspection and reference during normal working hours. If requested, produce and submit photocopies to Engineer.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013200

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SECTION 013233 - PHOTOGRAPHIC DOCUMENTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions and other Division 01 Specifications sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for the following:

1. Preconstruction photographs.
2. Concealed Work photographs.
3. Periodic construction photographs.
4. Time-lapse sequence construction photographs
5. Final Completion construction photographs.
6. Preconstruction video recordings.
7. Periodic construction video recordings.
8. Time-lapse sequence construction video recordings
9. Construction webcam.

B. Related Requirements:

1. Division 01 Section 017700 "Closeout Procedures" for submitting photographic documentation as Project Record Documents at Project Closeout.
2. Division 01 Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of the Employer's personnel.
3. Division 01 Section 024116 "Structure Demolition" for photographic documentation before building demolition operations commence.
4. Division 02 Section 024119 "Selective Demolition" for photographic documentation before selective demolition operations commence.
5. Division 03 Section 311000 "Site Clearing" for photographic documentation before site clearing operations commence.

1.3 DEFINITIONS

A. Taking Over: Substantial Completion.

1.4 INFORMATIONAL SUBMITTALS

A. Key Plan: Prior to the commencement date, submit for the approval of the Engineer a key plan of Project site and building with notation of vantage points marked for location and direction of each photograph and video recording. Indicate elevation or story of construction. Include same information as corresponding photographic documentation.

1. The key plan shall be reissued as part of the Contractor’s monthly report and shall indicate the elevation or story of construction of each photographic location.

B. Digital Photographs: Submit image files within three (3) days of taking photographs.

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1. Submit photos by uploading image files for each photograph to the web-based project management software. Include copy of key plan indicating each photograph's location and direction.
2. Identification: Provide the following information with each image description:

    a. Name of Project.
    b. Name and contact information for photographer.
    c. Name of the Engineer and Construction Manager.
    d. Name of Contractor.
    e. Date photograph was taken.
    f. Description of location, vantage point, and direction.
    g. Unique sequential identifier keyed to accompanying key plan.

C. Printed Photographs: Submit [**two (2)**] sets of prints of each photographic view within [**seven (7)**] days of taking photographs.

1. Format: 203-by-254-mm smooth-surface matte prints on single-weight, paper; enclosed back to back in clear plastic sleeves punched for three-ring binder. Include copy of key plan indicating each photograph's location and direction. Provide one binder for each set of prints.
2. Identification: On back of each print, label with the following information:

    a. Name of Project.
    b. Name and contact information for photographer.
    c. Name of the Engineer and Construction Manager**.**
    d. Name of Contractor.
    e. Date photograph was taken if not date stamped by camera.
    f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
    g. Unique sequential identifier keyed to accompanying key plan.

D. Video Recordings: Submit video recordings within three (3) days of recording.

1. Submit video recording by uploading to the web-based project management software. Include copy of key plan indicating each video's location and direction.
2. Identification: With each submittal, provide the following information:

    a. Name of Project.
    b. Name and contact information of photographer.
    c. Name of the Engineer [and Construction Manager].
    d. Name of Contractor.
    e. Date video recording was recorded.
    f. Description of vantage point, indicating location, direction (by compass point),
    g. and elevation or story of construction.
    h. Each video recording shall be narrated to explain the content.

E. Transcript: Prepare and submit a transcript of the narration with the submittal.

F. Time-Lapse Video: Submit time-lapse sequence video recordings within three (3) days of recording.

1. Submit time-lapse sequence video recordings monthly to the web-based project management software, as part of the monthly report.
2. Identification: For each recording, provide the following:

    a. Name of Project.
    b. Name and contact information for photographer.
    c. Name of the Engineer and Construction Manager.
    d. Name of Contractor.
    e. Date(s) and time(s) video recording was recorded.

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f. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.

1.5 QUALITY ASSURANCE

A. Photographer Qualifications: An individual who has been regularly engaged as a professional photographer of construction projects for not less than three years.

B. Construction Webcam Service Provider: A firm specializing in providing photographic equipment, web-based software, and related services for construction projects, with a record of providing satisfactory services similar to those required for Project.

1.6 FORMATS AND MEDIA

A. Digital Photographs: Provide color images in JPG format, produced by a digital camera with minimum sensor size of twelve (12) megapixels, and at an image resolution of not less than 3200 by 2400 pixels. Use flash in low light levels or backlit conditions.

B. Digital Video Recordings: Provide high-resolution, digital video in MPEG format, produced by a digital camera with minimum sensor resolution of twelve (12) megapixels and capable of recording in full high-definition mode with vibration-reduction technology. Provide supplemental lighting in low light levels or backlit conditions.

C. Digital Images: Submit digital media as originally recorded in the digital camera, without alteration, manipulation, editing, or modifications using image-editing software.

E. Metadata: Record accurate date and time and GPS location data from camera.

F. File Names: Name media files with date and Project area and sequential numbering suffix.

1.7 CONSTRUCTION PHOTOGRAPHS

A. Photographer: Engage a qualified photographer to take construction photographs.

B. General: Take photographs with maximum depth of field and in focus.

1. Maintain key plan with each set of construction photographs that identifies each photographic location and direction of view. The photographs shall be taken on the date coinciding with the cut-off date associated with each monthly statement. Following suggestions by the Engineer and Contractor, photographer shall select vantage points and directions from which the construction photographs should be taken.

C. Preconstruction Photographs: Before commencement of the Work, take photographs of Project site and surrounding properties, including existing items to remain during construction, from different vantage points, as directed by Engineer.

1. Flag construction limits before taking construction photographs.
2. Take a minimum of twenty (20) photographs to show existing conditions adjacent to property before starting the Work.
3. Take a minimum of twenty (20) photographs of existing buildings either on or adjoining property, to accurately record physical conditions at start of construction.
4. Take additional photographs as required to record settlement or cracking of adjacent structures, pavements, and improvements.

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D. Concealed Work Photographs: Before proceeding with installing work that will conceal other work, take photographs sufficient in number, with annotated descriptions, to record nature and location of concealed Work, including, but not limited to, the following:

1. Underground utilities.
2. Under slab services.
3. Piping.
4. Electrical conduit.
5. Waterproofing and weather-resistant barriers.

E. Abortive Works Photographs: Before demolition of any Works made abortive due to the issuance of a Variation Order, take sufficient photographs with annotated descriptions, to record the nature and location of the abortive Work and to adequately record the condition and progress of the Works prior to demolition. Where applicable, the photographs should include a survey grade rod to provide scale and establish measurements.

F. Periodic Construction Photographs: Take a minimum of fifty (50) photographs weekly. Select vantage points to show status of construction and progress since last photographs were taken.

G. Time-Lapse Sequence Construction Photographs: Take a minimum of twenty (20) photographs as indicated, to show status of construction and progress since last photographs were taken.

1. Frequency: Take photographs weekly.
2. Vantage Points: Following suggestions by Engineer and Contractor, photographer shall select vantage points. During each of the following construction phases, take not less than [**two (2)**] of the required shots from same vantage point each time, to create a time-lapse sequence as follows:

    a. Commencement of the Work, through completion of subgrade construction.
    b. Above-grade structural framing.
    c. Exterior building enclosure.
    d. Interior Work, through date of Taking Over.

H. Fabrication Photographs: Take an appropriate number of photographs each month of Works being carried out off-site at fabrication yards, factories, etc. in order to demonstrate production progress of key components as instructed by the Employer's Representative.

I. Sectional Completion Construction Photographs: When a section or part of the Works are taken over by the Employer, take a minimum of one hundred (100) photographs as requested by the Employer's Representative immediately after the date of Taking-Over for submission as Project Record Documents. The Employer's Representative will inform the photographer of the desired vantage points

J. Final Completion Construction Photographs: Take a minimum of hundred (100) photographs after date of Taking Over for submission as Project Record Documents. Engineer will inform photographer of desired vantage points.

K. Additional Photographs: The Engineer may request photographs in addition to periodic photographs specified free of charge.

1. Three days' notice will be given, where feasible.
2. In emergency situations, take additional photographs within 24 hours of request.
3. Circumstances that could require additional photographs include, but are not limited to, the following:

    a. Special events planned at Project site.
    b. Immediate follow-up when on-site events result in construction damage or losses.
    c. Photographs shall be taken at fabrication locations away from Project site. These photographs are not subject to unit prices or unit-cost allowances.

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d. Taking Over of a major phase or component of the Work.
e. Extra record photographs at time of final acceptance.
f. The Employer's request for special publicity photographs.

1.8 CONSTRUCTION VIDEO RECORDINGS

A. Video Recording Photographer: Engage a qualified videographer to record construction video recordings.

B. Narration: Describe scenes on video recording by audio narration by microphone while or dubbing audio narration off-site after video recording is recorded. Include description of items being viewed, recent events, and planned activities. At each change in location, describe vantage point, location, direction (by compass point), and elevation or story of construction.

1. Confirm date and time at beginning and end of recording.
2. Begin each video recording with name of Project, Contractor's name, videographer's name, and Project location.

C. Transcript: Provide a typewritten transcript of the narration. Display images and running time captured from video recording opposite the corresponding narration segment.

D. Preconstruction Video Recording: Before starting works, record video recording of Project site and surrounding properties from different vantage points, as directed by the Engineer .

1. Flag construction limits before recording construction video recordings.
2. Show existing conditions adjacent to Project site before starting the Work.
3. Show existing buildings either on or adjoining Project site to accurately record physical conditions at the start of any works onsite.
4. Show protection efforts by Contractor of existing structures and utilities.

E. Periodic Construction Video Recordings: Record video recording weekly. Select vantage points to show status of construction and progress since last video recordings were recorded. Minimum recording time shall be thirty (30) minutes(s).

F. Time-Lapse Sequence Construction Video Recordings: Record video recording to show status of construction and progress.

1. Appoint a suitably qualified and experienced subcontractor to install, monitor and maintain, two (2) time-lapse cameras. The time-lapse recordings must be taken on over the period coinciding with the cut-off date associated with each monthly Statement. Each video generated from the still photographs should cover one calendar month.
2. The cameras are to be located in positions that will not be disturbed by the works and the locations are to be maintained throughout construction. The Cameras are to be placed in elevated housings that are dust proof and weatherproof.
3. The position of the cameras, as well as the make and model of camera, resolution of the pictures, time interval between pictures, video frame rate and any other technical variables shall be approved by the Employer’s Representative prior to installation.
4. Final Completion Construction Video: When the Works are taken over by the Employer, the Contractor shall compile a time-lapse video of the entire construction period for each location for submission as Project Record Documents.
5. Frequency: During each of the following construction phases, set up video recorder to automatically record one frame of video recording every five (5) minutes, from same vantage point each time, to create a time-lapse sequence of thirty (30) minutes in length as follows:

a. Commencement of the Work, through completion of subgrade construction.
b. Above-grade structural framing.
c. Exterior building enclosure.

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6. Timer: Provide timer to automatically start and stop video recorder, so recording occurs only during work hours.
7. Vantage Points: Following suggestions by the Engineer and Contractor, photographer shall select vantage points.

1.9 CONSTRUCTION WEBCAM

A. Webcam: Provide two (2) fixed-location camera(s) with weatherproof housing, mounted to provide unobstructed view of construction site from location approved by the Engineer, with the following characteristics:

1. Remotely controllable view with mouse-click user navigation for horizontal pan, vertical tile, and optical zoom of 500 percent minimum.
2. Capable of producing minimum Twelve (12) megapixel images.
3. Provide power supply, active high-speed data connection to service provider's network, and static public IP address for each camera.

B. Live Streaming Images: Provide web-accessible image of current site image, updated at fifteen (15) minute intervals during daytime operation.

C. Web-Based Interface: Provide online interface to allow viewing of each high-definition digital still image captured and stored during construction, from the Internet.

1. Access Control: Provide password-protected access for Project team administered by Contractor, providing current image access and archival image access by date and time, with images downloadable to viewer's device.
2. Software: Provide responsive software interface for use on computer, tablet, and mobile screens with accompanying iPhone/iPad app and Android apps.
3. Storage: Maintain images on the website for reference during entire construction period, and for not less than 30 days after Final Completion. Provide sufficient memory on remote server to store all Project images.
4. Online Interface: Provide website interface with Project and client information and logos, calendar-based navigation interface for selecting images, and pan and zoom capability within high-definition images.
5. Forward and Reverse: Provide capability to browse through images, moving forward and backward in time by individual image and by day.
6. Slideshow: Provide capability to automatically display current images from sites when there are three or more cameras used.
7. Time-Lapse: Provide capability for online display of project time-lapse.
8. Dashboard: Provide capability to view thumbnails of all cameras on one screen.
9. Weather: Provide corresponding weather data for each image captured.
10. Provide secure role-based access to online Project cameras to the predefined, based on project specific requirements, authorized viewers / users.
11. Provide public viewer open access to most recent Project camera image.

D. Maintain cameras and web-based access in good working order, according to web-based construction photographic documentation service provider's written instructions until Final Completion. Provide for service of cameras and related networking devices and software.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013233

SECTION 013300 - SUBMITTAL PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions and other Division 01 Specifications sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Submittal schedule requirements.
2. Administrative and procedural requirements for design and construction submittals (product data, shop drawings. Samples, and others).

B. Related Requirements:

1. Division 01 Section 013100 "Project Management and Coordination" for submitting coordination drawings and subcontract list and for requirements for web-based Project software.
2. Division 01 Section 013200 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
3. Division 01 Section 013233 "Photographic Documentation" for submitting preconstruction photographs, periodic construction photographs, and Final Completion construction photographs.
4. Division 01 Section 014000 "Quality Requirements" for submitting test and inspection reports, and schedule of tests and inspections.
5. Division 01 Section 017700 "Closeout Procedures" for submitting closeout submittals and maintenance material submittals.
6. Division 01 Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
7. Division 01 Section 017839 "Project Record Documents" for submitting record Drawings, record Specifications, and record Product Data.
8. Division 01 Section 017900 "Demonstration and Training" for submitting video recordings of demonstration of equipment and training of Employer's personnel.
9. Division 01 Section 018113.14 - Sustainable Design Requirements
10. Division 25, Section 251521 “Integrated Automation Software - Digital Twin Platform and related Works”.
11. Specification sections related to the functionality and efficiency of the executed systems.

1.3 DEFINITIONS

A. Action Submittals: Written and graphic information and physical samples that require Engineer’s and Construction Manager's responsive action. Action submittals are those submittals indicated in individual Specification Sections as "action submittals."

B. Informational Submittals: Written and graphic information and physical samples that do not require Engineer’s and Construction Manager's responsive action. Submittals may be rejected for not complying with requirements. Informational submittals are those submittals indicated in individual Specification Sections as "informational submittals."

C. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.

D. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

E. Building Information Modeling (BIM): Refer to the Annexes of this Section.

1.4 SUBMITTAL SCHEDULE

A. Submittal Schedule: Submit, as an action submittal, a list of submittals, arranged in chronological order by dates required by construction schedule. Include time required for review, ordering, manufacturing, fabrication, and delivery when establishing dates. Include additional time required for making corrections or revisions to submittals noted by Engineer and Construction Manager and additional time for handling and reviewing submittals required by those corrections.

1. Coordinate submittal schedule with list of subcontracts, the schedule of values, and Contractor's construction schedule.
2. Initial Submittal Schedule: Submit concurrently with startup construction schedule. Include submittals required during the first 60 days of construction. List those submittals required to maintain orderly progress of the Work and those required early because of long lead time for manufacture or fabrication.
3. Final Submittal Schedule: Submit concurrently with the first complete submittal of Contractor's construction schedule.

    a. Update Submittals: Submit continuously revised submittal schedule as required to reflect changes in current status and timing for submittals. Submit an Update Submittals Schedule on the day before each regular Progress Meeting.

4. Format: Arrange the following information in a tabular format:

    a. Scheduled date for first submittal.
    b. Specification Section number and title.
    c. Submittal Category: Action; informational.
    d. Name of subcontractor.
    e. Description of the Work covered.
    f. Scheduled date for Engineer’s and Construction Manager's final release or approval.
    g. Scheduled dates for purchasing.
    h. Scheduled date of fabrication.
    i. Scheduled dates for installation.
    j. Activity or event number.

B. Project Design and Construction Building Information Modeling (BIM) ready for integration with Digital twin Platform Execution Plan: Submit for the Engineer's approval, not later than 14 days after the date of issue of the Letter of Acceptance, the Project Design and Construction BIM Execution Plan in accordance with the provisions of this Section. The Project Design and Construction BIM Execution Plan shall include, but is not limited to the following:

1. The Contractor’s and his sub-contractors and subconsultants’ roles, responsibilities and authorities.
2. Design and Construction BIM ready for integration with Digital twin Platform deliverables including but not limited to the Design and Construction BIM strategy and methodology.
1. The Master Information Delivery Plan (MIDP) listing the information deliverables for the project, including but not limited to models, drawings, specifications, equipment schedules, room data sheets. The MIDP shall be compiled by the Contractor and used to manage the

delivery of information during the project. The Contractor is expected to require all his Sub-Consultants, Sub-Contractors and project related team members, to compile their own Task Information Delivery Plans (TIDP), which will be used to communicate the responsibility for delivery of each party's scope of works. Milestones within each TIDP shall be aligned with the design and construction schedule and used to produce the MIDP. The TIPD's will be used to plan and communicate to all project related team members of the required sequence of model preparation for work packages used in the project. The Master Information Delivery Plan (MIDP) which consists of individual disciplines / Sub-Contractors Task Information Delivery Plans (TIDP) is to be held, managed, and regularly updated as per design and construction phases, milestones and submittals on the Common Data Environment by the Contractor.

2. Major project milestones consistent with the Contractor's design and construction schedule and the MIDP.
3. Project information model deliverable strategy, i.e. detailed strategy plans, diagrams, visual workflows describing the following:

    a. Project Design and Construction BIM Model ready for integration with Digital twin Platform collaboration after coordination with Sub-Contractors and other contractors on site.
    b. Clarification of all project's related team members ability and capability to develop, coordinate and submit their scope of works/services through a BIM Environment, and if not, to identify and detail a strategy to incorporate their required deliverables within the Project Design and Construction BIM Model.
    c. Process for Extraction of Design, Installation, Shop and other design and construction Drawings, Schedules, Details etc. for Engineer's approval and validation.
    d. Detailed workflows explaining and communicating the - subcontractors' coordination strategy between all various trades for clash detection, QA / QC of all submitted information against the Project Design and Construction BIM Model.
    e. Developing and Linking of the Project Design and Construction BIM Model ready for integration with Digital twin Platform with the Design and Construction schedule using 4D Planning and Scheduling software]in accordance with the requirements of this Section and Section 013200.
    f. Detailed strategy for the input and updating of As-Built conditions within the Project Design and Construction BIM Model and used tools.
    g. Details of Project BIM ready for integration with Digital twin Platform Uses through [Design and] Construction.
    h. The issuing and agreement of a Project BIM Protocol between all project related team members, detailing contractual roles, responsibilities and liabilities.
    i. Existing Survey strategy and existing legacy data use.
    j. eLOD / iLOD ready for integration with Digital twin Platform Matrices Tables in accordance with this section and annexes.

C. Project Design and Construction Execution Plan: Submit for the Engineer's approval, not later than 14 days after the date of issue of the Letter of Acceptance, the Project Design and Construction Execution Plan in accordance with the provisions of this Section. The Project Design and Construction Execution Plan shall include, but is not limited to the following:

1. The Contractor's and his sub-contractors and subconsultants' roles, responsibilities and authorities.
2. Design and Construction deliverables including but not limited to the Design and Construction methodology.
3. The list of deliverables listing the information deliverables for the project, including but not limited to drawings, specifications, equipment schedules, room data sheets. The list of deliverables shall be compiled by the Contractor and used to manage the delivery of information during the project. The Contractor is expected to require all his Sub-Consultants, Sub-Contractors and project related team members, to compile their own list of deliverables, which will be used to communicate the responsibility for delivery of each party's scope of works.
4. Major project milestones consistent with the Contractor's design and construction schedule.

5. Project delivery strategy, i.e. detailed strategy plans, diagrams, visual workflows describing the following:

    a. Shop and other design and construction Drawings, Schedules, Details etc. for Engineer's approval and validation.
    b. Detailed workflows explaining and communicating the subcontractors' coordination strategy between all various trades.
    c. Detailed strategy for the input and updating of As-Built conditions.
    d. Existing Survey strategy and existing legacy data use.

6. The Contractor's workflows during the Design and Construction process to capture and link all required record documents.

1.5 SUBMITTAL FORMATS

A. Submittal Information: Include the following information in each submittal:

1. Project name.
2. Date.
3. Name of Engineer.
4. **Name of Construction Manager.**
5.]Name of Contractor.
6. Name of firm or entity that prepared submittal.
7. Names of subcontractor, manufacturer, and supplier.
8. Unique submittal number, including revision identifier. Include Specification Section number with sequential alphanumeric identifier and alphanumeric suffix for resubmittals.
9. Category and type of submittal.
10. Submittal purpose and description.
11. Number and title of Specification Section, with paragraph number and generic name for each of multiple items.
12. Drawing number and detail references, as appropriate.
13. Indication of full or partial submittal.
14. Location(s) where product is to be installed, as appropriate.
15. Other necessary identification.
16. Remarks.
17. Signature of transmitter.

B. Options: Identify options requiring selection by Engineer.

C. Deviations and Additional Information: On each submittal, clearly indicate deviations from requirements in the Contract Documents, including minor variations and limitations; include relevant additional information and revisions, other than those requested by Engineer and Construction Manager on previous submittals. Indicate by highlighting on each submittal or noting on attached separate sheet.

D. Paper Submittals:

1. Place a permanent label or title block on each submittal item for identification; include name of firm or entity that prepared submittal.
2. Provide a space approximately 150 by 200 mm on label or beside title block to record Contractor's review and approval markings and action taken by Engineer and Construction Manager.
3. Action Submittals:

    a. Submit two (2) paper copies of each submittal unless otherwise indicated or instructed by the Engineer. The Engineer will return one (1) marked-up copy. The Contractor shall scan and provide a hard copy of the same.

4. Informational Submittals:

    a. Submit two (2) paper copies of each submittal unless otherwise indicated or instructed by the Engineer. The Engineer will not return copies unless deemed necessary by the Engineer.

5. Additional Copies: Unless additional copies are required for final submittal, and unless Engineer noncompliance with provisions in the Contract Documents, initial submittal may serve as final submittal.
6. Transmittal for Submittals: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using AIA Document G810] [facsimile of sample form included in Project Manual transmittal form.

E. Electronic Submittals:

1. Prepare submittals as PDF package, incorporating complete information into each PDF file. Name each PDF file with corresponding submittal number.
2. Contractor's submissions shall be done on a readable and searchable PDF document (or on the applicable format in case of drawings). Scanned images are not acceptable.

F. Submittals Utilizing Web-Based Project Software:

1. Prepare submittals as PDF files or other format as agreed with the Engineer. All PDF formats shall be readable and searchable files.

G. Wherever the Specifications of this Contract refer to 'copy or copies' in whatsoever form it means the 'copy or copies' read, reproduced, communicated and stored through the Web-based Project Software as defined in Section 013100, unless otherwise specified.

1.6 **[BIM]** SUBMITTAL ADMINISTRATIVE REQUIREMENTS

A. The Contractor is required to abide by this Section and its Annexes for the definition and requirements of the Building Information Modeling (BIM) ready for integration with Digital twin Platform development and submissions.

B. The Contractor is required to share his BIM Model(s) with the Engineer for coordination with the Project's BIM model(s) as deemed necessary by the Engineer. Upon appending the Contractor's BIM models with the Engineer's, the Engineer may request the Contractor to undertake modifications to his model in order to align it with the surrounding structures and systems; the Contractor shall undertake these modifications.

C. Engineer's Digital Data Files: Electronic digital data files of the Contract Drawings will be provided by Engineer for Contractor's use in preparing submittals.

1. Pre-Contract Award: Tenderers will be provided with the design stage BIM Models in Navisworks (NWD) file format.
2. Post Contract Award: Awarded Contractor will be provided with the Engineer's Design Stage Project BIM Models in Native File Format and a Combined Navisworks (NWD) File Format to the level specified in the annexes of this Section, at the Commencement Date.

D. The Contractor shall follow the Contract drawings and Engineer's Design Stage Project BIM Model ready for integration with Digital twin Platform for the development of his Federated BIM Model(s). In case of discrepancy between the Contract drawings and the Engineer's Design Stage Project BIM Model, the following order of priority shall be followed:

1. Contract drawings.
2. Engineer's Design Stage Project BIM Model.

E. Engineer's Digital Data Files: Electronic digital data files of the Contract Drawings will be provided by Engineer for Contractor's use in preparing submittals.

1. Post Contract Award: Awarded Contractor will be provided with the Engineer's Design Stage Drawings at the Commencement Date.

F. The Contractor shall follow the Contract drawings and Engineer's Design Stage Drawings for the development of the Contractor's submittals.

1.7 SUBMITTAL PROCEDURES

A. Prepare and submit submittals required by individual Specification Sections. Types of submittals are indicated in individual Specification Sections.

1. Post electronic submittals as BIM models ready for integration with Digital twin Platform in their native file format and PDF electronic files via Employer's Project Management System, or any other Common Data Environment (CDE) designated by the Employer documentation as referenced below, for purposes of all project communication and submissions.

   a. The Engineer will return annotated file. Retain one copy of file as an electronic Project record document file.

2. Provide the Building Information Model(s) as listed in, and required by this Section (and Annexes) and individual Specification Sections, for each element of the project in native format, which should also include the Master Information Delivery Plan (MIDP) listing the information deliverables required for the project, including but not limited to models, drawings, specifications, equipment schedules, room data sheets etc. including software type and version used to create the models. Integrated Models submitted by the Contractor will demonstrate to the Engineer that model development has been fully completed for the related section, is fully coordinated, clash free, and complies with the Specification and the annexes to this Section.
3. Any design related data or submittals not extracted from BIM will be labelled as "Not from BIM", subject to Employer Approval. Any data drops not generated from BIM will be listed within the Contractors project BIM Execution Plan.
4. Email: Prepare submittals as PDF package and transmit to Engineer by sending via email. Include PDF transmittal form. Include information in email subject line as requested by Engineer.

   a. Engineer will return annotated file. Retain one copy of file as a digital Project Record Document file.

5. Web-Based Project Management Software: Prepare submittals in PDF form, and upload to web-based Project management software website. Enter required data in web-based software site to fully identify submittal.
6. Paper: Prepare submittals in paper form and deliver to Engineer.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities.

1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.
2. Submit all submittal items required for each Specification Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.
3. Submit action submittals and informational submittals required by the same Specification Section as separate packages under separate transmittals.
4. Coordinate transmittal of submittals for related parts of the Work specified in different Sections, so processing will not be delayed because of need to review submittals concurrently for coordination.

a. Engineer reserves the right to reject action on a submittal requiring coordination with other submittals until related submittals are received.

5. Transmit each submittal sufficiently in advance of performance of related procurement and construction activities, allowing ample time for review and resubmittal if necessary, in order to prevent delays to the work.

C. Processing Time: Allow time for submittal review, including time for resubmittals, as follows. Time for review shall commence on Engineer's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including resubmittals.

1. Initial Review: Allow fifteen (15) days for initial review of each submittal. Allow additional time if coordination between multiple trades and / or with subsequent submittals is required. Engineer will advise Contractor when a submittal being processed must be delayed for coordination.
2. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
3. Resubmittal Review: Allow Seven (7) days for review of each resubmittal.
4. Sequential Review: Where sequential review of submittals by Engineer's consultants, Employer, or other parties is indicated, allow twenty-one (21) days for initial review of each submittal.

5. Concurrent Consultant Review: Where the Contract Documents indicate that submittals may be transmitted simultaneously to Engineer and to Engineer's consultants, allow twenty-one (21) days for review of each submittal. Submittal will be returned to Engineer before being returned to Contractor.

a. Submit one (1) copy of submittal to concurrent reviewer in addition to specified number of copies to Engineer.

D. Paper Submittal: Include the following information for processing and recording action taken:

a. Project name.
b. Date.
c. Name and address of Engineer.
d. Name and address of Contractor.
e. Name and address of subcontractor.
f. Name and address of supplier.
g. Name and address of manufacturer.
h. Submittal number or other unique identifier, including revision identifier.

1) Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g., 061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., 061000.01.A) or as agreed upon with the Engineer.

i. Number and title of appropriate Specification Section.
j. Drawing number and detail references, as appropriate.
k. Location(s) where product is to be installed, as appropriate.
l. Other necessary identification.
m. Revision number.
n. Revision notes.
o. Company stamp.
p. Company representative signature.

E. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:

1. Assemble complete submittal package into a single indexed file incorporating submittal requirements of a single Specification Section and transmittal form with links enabling navigation to each item.
2. Name file with submittal number or other unique identifier, including revision identifier.

    a. File name shall use project identifier and Specification Section number followed by a decimal point and then a sequential number (e.g., LNHS-061000.01). Resubmittals shall include an alphabetic suffix after another decimal point (e.g., LNHS-061000.01. A). or as agreed upon with the Engineer

3. Provide means for insertion to permanently record Contractor's review and approval markings and action taken by Engineer.
4. Include the following information on an inserted cover sheet:

    a. Project name.
    b. Date.
    c. Name of Engineer.
    d. Name of Employer.
    e. Name of Contractor.
    f. Name of firm or entity that prepared submittal.
    g. Name of subcontractor.
    h. Name of supplier.
    i. Name of manufacturer.
    j. Number and title of appropriate Specification Section.
    k. Drawing number and detail references, as appropriate.
    l. Location(s) where product is to be installed, as appropriate.
    m. Related physical samples submitted directly.
    n. Other necessary identification.

5. Include the following information as keywords in the electronic file metadata:

    a. Project name.
    b. Number and title of appropriate Specification Section.
    c. Manufacturer name.
    d. Product name.
    e. Insert additional required information.

F. Options: Identify options requiring selection by the Engineer.

G. Transmittal for Submittals: Assemble each submittal individually and appropriately for transmittal and handling. Transmit each submittal using a transmittal form. attached to a cover letter. The Engineer will discard, without review, submittals received from sources other than the Contractor.

1. Cover Letter: On attached, numbered, separate sheet(s), prepared on the Contractor's letterhead, record relevant information, requests for data, revisions other than those requested by the Engineer on previous submittals, and deviations from requirements of the Contract Documents, including minor variations and limitations. Include the same label information as the related submittal.

    a. Include Contractor's certification stating that information submitted complies with requirements of the Contract Documents.

2. Transmittal Form: Use a form acceptable to and approved by the Engineer Provide locations on form for the following information:

3. Transmittal Form: Provide locations on form for the following information:

    a. Contract name.
    b. Employer’s name.

c. Date.
d. Destination (To:).
e. Source (From:).
f. Name and address of Engineer.
g. Name and address of Contractor.
h. Name and address of firm or entity that prepared submittal.
i. Names of subcontractor, manufacturer, and supplier.
j. Category and type of submittal.
k. Submittal purpose and description.
l. Specification Section number and title.
m. Specification paragraph number or drawing designation and generic name for each of multiple items.
n. Indication of full or partial submittal.
o. Drawing number and detail references, as appropriate.
p. Location(s) where product is to be installed, as appropriate.
q. Submittal and transmittal distribution record.
r. Remarks.
s. Signature of transmitter.

H. Resubmittals: Make resubmittals in same form and number of copies as initial submittal.

1. Note date and content of previous submittal.
2. Note date and content of revision in label or title block, and clearly indicate extent of revision.
3. Resubmit submittals until they are marked with approval notation from Engineer’s action stamp.

I. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for performance of construction activities. Show distribution on transmittal forms.

J. Use for Construction: Retain complete copies of submittals on Project site. Use only final action submittals that are marked with approval notation from Engineer’s action stamp.

1.8 SUBMITTAL REQUIREMENTS

A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. Provide only copies of original manufacturer published or printed product information, catalogues, data, colour charts and the like.
2. If information must be specially prepared for submittal because standard published data are not suitable for use, submit as Shop Drawings, not as Product Data.
3. Mark each copy of each submittal to show which products and options are applicable.
4. Include the following information, as applicable:

a. Manufacturer's catalog cuts.
b. Manufacturer's written recommendations.
c. Manufacturer's product specifications.
d. Manufacturer's installation instructions.
e. Standard color charts.
f. Statement of compliance with specified referenced standards.
g. Testing by recognized testing agency.
h. Application of testing agency labels and seals.
i. Notation of coordination requirements.
j. Availability and delivery time information.

5. For equipment, include the following in addition to the above, as applicable:

a. Wiring diagrams showing factory-installed wiring.
b. Printed performance curves.
c. Operational range diagrams.
d. Mill reports.
e. Standard product operating and maintenance manuals.
f. Compliance with recognized trade association standards.
g. Compliance with recognized testing agency standards.
h. Application of testing agency labels and seals.
i. Notation of coordination requirements.
j. Clearances required to other construction, if not indicated on accompanying Shop Drawings.

6. Submit Product Data before shop drawings and before or concurrently with samples in the following format:

a. One PDF electronic file.
b. Two (2) paper copies of Product Data. The Engineer will return one (1) marked-up copy. The Contractor shall scan and provide a hard copy of the same.

B. BIM Model(s), Design, Installation, Coordination, Shop and Record (As-Built) Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.

1. BIM File Incorporation: Develop and submit the Project information Models (PIM) to the level specified in this section and its Annexes, and submit the extracted Drawing files in the following order:

a. The Contractor shall submit the Project information Models (PIM) to the Engineer to facilitate his coordination review of the drawings.
b. The Contractor shall extract the Drawings from the Project information Models (PIM) and submit them to the Engineer's approval, in the same digital data software program, version, and operating system as the original Drawings. The relevant Project information Models (PIM) is provided to the Engineer to facilitate his coordination review of the submitted drawings.

C. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data unless submittal based on Engineer's digital data drawing files is otherwise permitted.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:

a. Identification of products.
b. Schedules.
c. Compliance with specified standards.
d. Notation of coordination requirements.
e. Notation of dimensions established by field measurement.
f. Relationship and attachment to adjoining construction clearly indicated.
g. Seal and signature of professional engineer if specified.
h. Design calculations

2. Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.
3. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least A2 size, and no larger than A0 size, unless otherwise approved.
4. Submittals:

a. PDF electronic files.
b. Two (2) opaque (bond) copies of each submittal.
c. PDF electronic files and one (1) opaque (bond) copies of each submittal.

5. BIM file Incorporation: Develop, coordinate and extract Installation Shop Drawings from Building Information Model ready for integration with Digital twin Platform established for the Project and in accordance with this Section's Annexes and in the same digital data software program, version, and operating system as the original Drawings.

    a. Refer to Section 013100 "Project Management and Coordination" for other requirements for coordination drawings.

D. Samples: Submit Samples for review of type, color, pattern, and texture for a check of these characteristics with other materials.

1. Transmit Samples that contain multiple, related components, such as accessories together in one submittal package.
2. Identification: Permanently attach label on unexposed side of Samples that includes the following:

    a. Project name and submittal number.
    b. Generic description of Sample.
    c. Product name and name of manufacturer.
    d. Sample source.
    e. Number and title of applicable Specification Section.
    f. Specification paragraph number and generic name of each item.

3. Email Transmittal: Provide PDF transmittal. Include digital image file illustrating Sample characteristics and identification information for record.
4. Web-Based Project Management Software: Prepare submittals in PDF form, and upload to web-based Project software website. Enter required data in web-based software site to fully identify submittal.
5. Paper Transmittal: Include paper transmittal, including complete submittal information indicated.
6. Disposition: Maintain sets of approved Samples at Project site, available for quality-control comparisons throughout the course of construction activity. Sample sets may be used to determine final acceptance of construction associated with each set.

    a. Samples that may be incorporated into the Work are indicated in individual Specification Sections. Such Samples must be in an undamaged condition at time of use.
    b. Samples not incorporated into the Work, or otherwise designated as Employer's property, are the property of Contractor.

7. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units, showing the full range of colors, textures, and patterns available.

    a. Number of Samples: Submit one (1) full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. The Engineer will return submittal with options selected.

8. Samples for Verification: Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

    a. Number of Samples: Submit three (3) sets of Samples. Engineer will retain two (2) Sample sets. Remainder will be returned. Mark up and retain one returned Sample set as a project record Sample.

1) Submit a single Sample where assembly details, workmanship, fabrication techniques, connections, operation, and other similar characteristics are to be demonstrated.
2) If variation in color, pattern, texture, or other characteristic is inherent in material or product represented by a Sample, submit at least three (3) sets of paired units that show approximate limits of variations. Prepare physical units of materials or products comply with requirements in Section 014000 “Quality Requirements” for Mockup.

E. Product Schedule: As required in individual Specification Sections, prepare a written summary indicating types of products required for the Work and their intended location. Include the following information in tabular form:

1. Type of product. Include unique identifier for each product indicated in the Contract Documents or assigned by Contractor if none is indicated.
2. Manufacturer and product name, and model number if applicable.
3. Number and name of room or space.
4. Location within room or space.
5. Submit product schedule in the following format:

a. Electronic file in the format agreed upon by the Engineer.
b. Number of Copies: Two (2) paper copies of product schedule or list, unless otherwise indicated. The Engineer will return one marked-up copy.

F. Contractor's Construction Schedule: Comply with requirements specified in Division 01 Section "Construction Progress Documentation".

G. Subcontract List: Prepare and submit a list identifying subcontractor individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:

1. Name, address, and telephone number of entities performing subcontract or supplying products.
2. Number and title of related Specification Section(s) covered by subcontract.
3. Drawing number and detail references, as appropriate, covered by subcontract.

4. Submit subcontract list in the following format:

a. PDF Electronic file.
b. Number of Copies: Two (2) paper copies of subcontractor list, unless otherwise indicated. The Engineer will return one marked-up copy.

H. Sustainability Submittals: Comply with requirements specified in Division 01 Section "Sustainable Design Requirements."

1. Submit Sustainability submittals in the following format:

a. One PDF Electronic file.
b. Number of Copies: Two (2) paper copies of sustainability submittals, unless otherwise indicated. The Engineer will return one marked-up copy.

I. Coordination Drawings: Comply with requirements specified in Division 01 Section "Project Management and Coordination."

J. General: Prepare and submit Informational Submittals required by other Specification sections.

1. Certificates and Certifications: Provide a notarised statement that includes signature of the Contractor, testing agency, or design professional responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of the company.
2. Test and Inspection Reports: Comply with requirements in Section 1 Part 10 "Quality Requirements.

K. Qualification Data: Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, contact information of Engineers and Employers, and other information specified.

L. Design Data: Prepare and submit written and graphic information indicating compliance with indicated performance and design criteria in individual Specification Sections. Include list of assumptions and summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Number each page of submittal.

M. Certificates:

1. Certificates and Certifications Submittals: Submit a statement that includes signature of entity responsible for preparing certification. Certificates and certifications shall be signed by an officer or other individual authorized to sign documents on behalf of that entity. Provide a notarized signature where indicated.
2. Installer Certificates: Submit written statements on manufacturer's letterhead, certifying that Installer complies with requirements in the Contract Documents and, where required, is authorized by manufacturer for this specific Project.
3. Manufacturer Certificates: Submit written statements on manufacturer's letterhead, certifying that manufacturer complies with requirements in the Contract Documents. Include evidence of manufacturing experience where required.
4. Material Certificates: Submit written statements on manufacturer's letterhead, certifying that material complies with requirements in the Contract Documents.
5. Product Certificates: Submit written statements on manufacturer's letterhead, certifying that product complies with requirements in the Contract Documents.
6. Welding Certificates: Prepare written certification that welding procedures and personnel comply with requirements in the Contract Documents. Submit record of Welding Procedure Specifications and Procedures Qualification Record (PQR) on American Welding Society AWS B2.1/B2.1M forms. Include names of firms and personnel certified.
7. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
8. Product Test Reports: Submit written reports indicating current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

N. Test and Research Reports:

1. Compatibility Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for substrate preparation and primers required.
2. Field Test Reports: Submit written reports indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in the Contract Documents.
3. Material Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in the Contract Documents.
4. Preconstruction Test Reports: Submit reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before

installation of product, for compliance with performance requirements in the Contract Documents.

5. Product Test Reports: Submit written reports indicating that current product produced by manufacturer complies with requirements in the Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.
6. Research Reports: Submit written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project. Include the following information:

    a. Name of evaluation organization.
    b. Date of evaluation.
    c. Time period when report is in effect.
    d. Product and manufacturers' names.
    e. Description of product.
    f. Test procedures and results.
    g. Limitations of use.

O. Schedule of Tests and Inspections: Comply with requirements specified in Division 01 Section "Quality Requirements".

P. Maintenance Data: Comply with requirements specified in Division 01 Section "Operation and Maintenance Data".

Q. Manufacturer's Instructions: Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturers. Include the following, as applicable:

1. Preparation of substrates.
2. Required substrate tolerances.
3. Sequence of installation or erection.
4. Required installation tolerances.
5. Required adjustments.
6. Recommendations for cleaning and protection.

R. Manufacturer's Field Reports: Prepare written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:

1. Name, address, and telephone number of factory-authorized service representative making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Statement that products at Site comply with requirements.
4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
6. Statement whether conditions, products, and installation will affect warranty.
7. Other required items indicated in individual Specification Parts.

S. Insurance Certificates and Bonds: Prepare written information indicating current status of insurance or bonding coverage. Include name of entity covered by insurance or bond, limits of coverage, amounts of deductibles, if any, and term of the coverage.

1.9 DELEGATED DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are insufficient to perform services or certification required, submit a written request for additional information to Engineer.

B. Delegated Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit **digitally signed PDF file and three** paper copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional.

1. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

C. BIM Incorporation: Incorporate delegated design drawing and data files into BIM ready for integration with Digital twin Platform established for Project.

1. Prepare delegated design drawings in the following format: Same digital data software program, version, and operating system as original Drawings.

1.10 CONTRACTOR'S REVIEW

A. Action Submittals and Informational Submittals: Review each submittal and check for coordination with other Work of the Contract and for compliance with the Contract Documents. Note corrections and field dimensions. Mark with approval stamp before submitting to Engineer.

B. In "Contractor's Approval" Paragraph below, retain first option for paper submittals and second option for digital submittals.

C. Contractor's Approval: Indicate Contractor's approval for each submittal with a uniform approval stamp indication in web-based Project management software. Include name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

1. Engineer will not review submittals received from Contractor that do not have Contractor's review and approval.

D. Project Take Over and Maintenance / Material Submittals: Refer to requirements in Division 01 Section 017700 "Closeout Procedures".

E. Approval Stamp: Stamp and / or electronically stamp each submittal with a uniform, approval stamp. Include Contract name and location, submittal number, Specification Section title and number, name of reviewer, date of Contractor's approval, and statement certifying that submittal has been reviewed, checked, and approved for compliance with the Contract Documents.

1.11 ENGINEER'S REVIEW

A. Action Submittals: The Engineer will review each submittal, indicate corrections or revisions required.

1. PDF Submittals: Engineer will indicate, via markup on each submittal, the appropriate action as follows:

a. Code A: Where the submittal is marked "Code A", the work covered by the submittal may proceed provided it complies with the Contract Documents. Final acceptance of the work will depend on that compliance.
b. Code B: Where the submittal is marked "Code B", the work covered by the submittal may proceed provided it complies with both the Engineer's notations and corrections on the submittal and the Contract Documents. Final acceptance of the work will depend on that compliance.
c. Code C: Where the submittal is marked "Code C", do not proceed with the work covered by the submittal, including purchase, fabrication, delivery, or other activity for the product submitted. Revise according to the Engineer's notations and corrections and in compliance with the Contract Documents.
d. Code D: Where the submittal is marked "Code D", the submittal is considered “Rejected” and should be revised in its entirety or prepare a new submittal.
e. Code E: Where the submittal is marked "Code E". Submittal is considered “For information”.

2. Paper Submittals: Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action as follows:

a. Code A: Where the submittal is marked "Code A", the work covered by the submittal may proceed provided it complies with the Contract Documents. Final acceptance of the work will depend on that compliance.
b. Code B: Where the submittal is marked "Code B", the work covered by the submittal may proceed provided it complies with both the Engineer's notations and corrections on the submittal and the Contract Documents. Final acceptance of the work will depend on that compliance.
c. Code C: Where the submittal is marked "Code C", do not proceed with the work covered by the submittal, including purchase, fabrication, delivery, or other activity for the product submitted. Revise according to the Engineer's notations and corrections and in compliance with the Contract Documents.
d. Code D: Where the submittal is marked "Code D", the submittal is considered “Rejected” and should be revised in its entirety or prepare a new submittal.
e. Code E: Where the submittal is marked "Code E". Submittal is considered “For information”.

3. Submittals by Web-Based Project Management Software: Engineer will indicate electronically, on Project management software website, the appropriate action as follows:

a. Code A: Where the submittal is marked "Code A", the work covered by the submittal may proceed provided it complies with the Contract Documents. Final acceptance of the work will depend on that compliance.
b. Code B: Where the submittal is marked "Code B", the work covered by the submittal may proceed provided it complies with both the Engineer's notations and corrections on the submittal and the Contract Documents. Final acceptance of the work will depend on that compliance.
c. Code C: Where the submittal is marked "Code C", do not proceed with the work covered by the submittal, including purchase, fabrication, delivery, or other activity for the product submitted. Revise according to the Engineer's notations and corrections and in compliance with the Contract Documents.
d. Code D: Where the submittal is marked "Code D", the submittal is considered “Rejected” and should be revised in its entirety or prepare a new submittal.
e. Code E: Where the submittal is marked "Code E". Submittal is considered “For information”.

B. Informational Submittals: Engineer will review each submittal and will not return it unless deemed necessary by the Engineer. Engineer will forward each submittal to appropriate party.

C. Partial submittals prepared for a portion of the Work will be reviewed when use of partial submittals has received prior approval from Engineer.

D. Incomplete submittals are unacceptable, will be considered nonresponsive, and will be returned for resubmittal without review.

E. Engineer will discard submittals received from sources other than Contractor.

F. Submittals not required by the Contract Documents will be returned by Engineer without action.

G. The Engineer will not review submittals that do not bear the Contractor's approval stamp and will return them without action.

H. Engineer's Action: The Engineer's review is limited only to checking conformance with information given and the design concept expressed in the Contract Documents. It is not conducted for the purpose of determining the accuracy and completeness of details, dimensions or quantities, nor substantiating integrity or compatibility, nor confirming instructions for installation or performance. The Engineer’s approval does not in any way relieve the Contractor of responsibility for compliance with specified provisions and the Contract Document requirements.

1.12 MOCKUP REQUIREMENTS

A. General: Construct and erect complete mock-up in accordance with the directions of the Employer and Engineer, and in the location determined by the Engineer and as required in the Contract Documents.

B. Comply with the comments of the Employer and the Engineer with the respect to the product, colour scheme and workmanship.

C. Revise product submittal, if necessary, in accordance with the Employer and the Engineer Comments.

1.13 ATTACHMENTS

A. Employer’s Exchange Information Requirements (EIR).

B. Engineer’s Project’s BIM Execution Plan.

1.14 EMPLOYER'S EXCHANGE INFORMATION REQUIREMENTS (EIR)

1.15 ENGINEER'S PROJECT'S BIM EXECUTION PLAN

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013300

SECTION 013510 - STRUCTURAL MONITORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes provisions for a structural monitoring system to measure loads and settlements under the foundations of high towers or highly loaded bridge piers, strains in selected members such as transfer slab, transfer beams, main columns and walls, highly post-tensioned bridge deck, at the soffit of bridge deck at long span mid span, monitor movements at the top of the tallest tower, critical expansion joint location, at the top of bridge long pier, at bridge deck expansion joint, monitoring acceleration of the tower or critical floor slab, monitoring vibration of critical long span and long cantilever structural members, at bridge flexible decks such as cable stay and suspended bridges, monitoring corrosion of critical structural steel members and reinforcement bars within critically exposed reinforced concrete elements at bridge structural elements that are subject to wetting and drying or at sea splash zones, or near the sea shoreline in substructures exposed to saline groundwater and monitoring crack widths of critically exposed concrete sections at the top of concrete section at continuous bridge decks at pier location, at the bottom face of the deck concrete section at midspans, at the face of abutment that is exposed to soil. This shall be implemented in close coordination and under the supervision of the Engineer. The scope also includes providing equipment for data collection, processing, interpretation, hardware and software that are required for a seamless interface to an integration platform or Cloud based solution, including Digital Twins, without the need for any additional licenses, in addition to training personnel designated by the Employer for the use and maintenance of the equipment.

B. Carry out the Work in such a manner that will not interfere with preset construction schedule.

C. Related Sections include the following:

1. Section 031000 "Concrete Reinforcing".
2. Section 033000 "Cast-in-place-concrete".

1.3 SUBMITTALS

A. Submit a detailed program and method statements to carry out the requested measurements and monitoring. This shall include the technical details of the proposed gages, equipment, and sensors devices together with the data acquisition technique and equipment, as well as the location where each probe is proposed to be fixed, interfacing components**,** and the digital twin platform and software. Arrangement for automated measuring and connection with GIS system are essential with provision for manual measuring.

B. Submit details (including samples) of the structural monitoring devices, including all technical data and manuals, for approval prior to installation.

C. Submit calibration certificates, installation procedures, and integration documentation with the Digital Twin platform.

D. Submit a layout for proposed location for installation of the structural monitoring devices for the Engineer's approval.

1. Prioritize placement under high-load or sensitive zones.
2. Ensure sensor layout integrates with the digital twin interface: real-time data feed, cloud storage, and automated alerts.
3.]Use a zoned deployment strategy: dense monitoring in high-value areas (e.g., major foundations, under major loads), and lower density elsewhere.

1.4 QUALITY ASSURANCE

A. Equipment shall demonstrate compliance with requirements specified in Section 016000.

PART 2 - PRODUCTS

2.1 PRESSURE CELLS

A. Pressure cells shall be manufactured from stainless steel, grade 316 S13 to BS EN 10088-3 or equivalent, and fixed to the blinding concrete face or to the soil underneath as per the standard procedures provided in writing by the manufacturer, subject to the approval of the Engineer.

B. The pressure cells shall include a thermistor for temperature measurement, in order to allow the computerized monitoring system that reads from the cells to make appropriate corrections of readings depending on temperature variations.

C. Pressure cells shall be able to measure the pressures under the foundation up to [**50**] <**Specify**> kg/cm2.

D. Computerized remote monitoring system, including monitoring equipment and instruments, capable of interfacing with integration platform or Cloud based solution, including Digital Twins, for the soil stresses under selected foundation related to selected structures] [the soil stresses under selected foundation related to high towers, the soil stresses under foundation related to highly loaded bridge piers, shall be installed at selected points, to enable the determination and evaluation of the soil stresses under foundations <insert description> during and after construction, in accordance with an agreed program in order to ensure that soil stresses are within the predicted range. The monitoring scheme is concerned with the acquisition of measurements required to determine the magnitude of soil stresses incurred under the structural foundation supporting the selected structures] <insert description as the structure loads are applied.

E. Selection of the locations of the points for soil stresses measurement shall be agreed upon among the Engineer, the Designer, and the Contractor.

2.2 SETTLEMENT MONUMENTS

A. Settlement of the foundation during construction shall be determined by repeated surveying of the elevation of monuments installed directly on the surface of the structural raft relative to a stationary bench mark. The stationary benchmark for monitoring shall be established and agreed upon before the commencement of construction.

B. The settlement of the top of the settlement markers shall be measured using precise leveling to an accuracy of plus or minus 0.5 mm.

C. The precise levels shall have robust tripods; leveling studs are to be provided for the purpose of precise leveling.

D. The leveling studs shall be:

1. Manufactured from stainless steel, grade 316 S13 to BS EN 10088-3 or equivalent;
2. Fixed to the concrete face by using a standard procedure subject to the approval of the Engineer;
3. Designed for use with precise leveling so as not to impair the accuracy specified above;
4. Designed such that the heads of the leveling studs can be easily leveled without the studs being vulnerable to damage.

E. Computerized remote monitoring system, including monitoring equipment and instruments, capable of interfacing with integration platform or Cloud based solution, including Digital Twins, for the foundation under selected structures, shall be installed at selected points, to enable the determination and evaluation of the foundation movement under gradual application of the building loads during and after construction in accordance with an agreed program in order to ensure that loads and settlement are within the predicted range. The monitoring scheme is concerned with the acquisition of measurements required to determine the magnitude of the settlement and load incurred on the structural foundation supporting the selected structures as the structure loads are applied. To that end, the monitoring scheme shall provide data to evaluate the two settlement parameters as defined below:

1. Maximum settlement: The maximum downward movement of any monitoring point from its initial position.
2. Differential settlement: The difference in vertical movement between any two adjacent settlement points.

F. Selection of the locations of the points for load and settlement measurement shall be agreed upon among the Engineer, the Designer, and the Contractor.

2.3 STEEL REINFORCEMENT AND CONCRETE STRAIN GAGES

A. Steel electrical strain gages mounted on the steel reinforcement by bonding using special epoxy at specified locations.

B. The gages shall be supplied with all necessary wiring and bonding agents. The strain gages shall not be adversely affected by temperature and shall satisfy the following as a minimum:

1. Standard range: 3000 micro-strain.
2. Sensitivity: 1 micro-strain.
3. Temperature range: 0 to 80 deg. C.

C. Embedded strain gages shall be especially designed for measuring mechanical strains in the concrete mass. The gage shall be attached to the steel reinforcement to measure concrete strain close to the steel reinforcement. The gage shall be supplied with all necessary wiring and necessary attachments. Technical specifications shall satisfy the following as a minimum:

1. Standard range: 3000 micro-strain.
2. Sensitivity: 1 micro-strain.
3. Temperature range: 0 to 80 deg. C.

D. Computerized remote monitoring system, including monitoring equipment and instruments, to ensure that strains, and hence loads and moments, are within the predicted range. The monitoring scheme is concerned with the acquisition of measurements required to determine the magnitude and disposition of the strains incurred on the structural element as the structure loads are applied. To that end, the monitoring scheme shall provide data to evaluate the two strain parameters defined below:

1. Concrete strains: Applicable for the vertical elements and the compression zone of the transfer slab, main columns and walls, highly post-tensioned bridge deck and other structural elements.
2. Steel strains: Applicable to the tension zone of at the soffit of bridge deck at long span mid span, transfer slab, transfer beams and other steel elements.

E. Selection of the locations of the points for strain measurement shall be agreed upon among the Engineer, the Designer, and the Contractor.

2.4 REAL TIME KINEMATICS - GLOBAL POSITIONING SYSTEM MOVEMENT MONITORING

A. The RTK-GPS system shall be especially designed for measuring the movements of the designated structural elements.

B. The sensor is to be installed as recommended by the manufacturer, and is to be supplied with all necessary wiring or hardware for wireless connectivity and necessary attachments and power source.

C. The system is to be composed of the following:

1. One base station comprising a dual-frequency, geodetic-grade GPS receiver installed at a nearby station, complete with mounting brackets, accessories, and battery backup for operation for up to one day without power.
2. One “rover” station comprising a dual-frequency GPS receiver to be installed on the agreed position at the topmost floor of the tower] [control locations within critical structures,[at the top of bridge long pier,at bridge deck expansion joint and other elements where applicable.
3. Control center PC running the real time monitoring software, with all associated communication links between the control center PC and the base and rover receivers.
4. One roof-mounted UVW anemometer.
5. One three-directional accelerometer with a suitable frequency range.
6. Data logging system to capture the data from the GPS system as well as signals from the other sensors, such as anemometers and accelerometers, and to compute, for predefined periods, statistics for each of the measuring components.
7. The system shall provide accurate positional information of up to10 samples per second.

D. Computerized remote monitoring system, including monitoring equipment and instruments, to monitor the effects of the natural phenomena on the buildings, mainly the wind and earthquake effects, and verify that the actual dynamic structural properties in terms of movements are within the predicted range throughout the life span of the project. The monitoring scheme is concerned with the acquisition of measurements required to determine the magnitude of movements of the tallest building, major parts of critical structures, specific critical tall building expansion joint location, the top of bridge long pier, the bridge deck expansion joint using RTK-GPS system.

E. Selection of the locations of the points for the RTK-GPS system shall be agreed upon between the Engineer, the Designer, and the Contractor.

2.5 ACCELERATION AND VIBRATION SENSOR

A. Acceleration/Vibration sensor shall be especially designed for measuring the acceleration/vibration of the designated structural elements.

B. The sensor is to be installed as recommended by the manufacturer, and is to be supplied with all necessary wiring or hardware for wireless connectivity and necessary attachments and power source.

C. Technical specifications shall satisfy the following as a minimum:

1. Sampling interval: adjustable between 50 to 500 samples/sec.
2. Sensitivity threshold: adjustable between 8 m.g to 500 m.g.

3. Resolution: 4 u.g (“g” is the acceleration due to gravity).
4. Shock survival: 1000g, 0.1s, no damage to the electronics.
5. Acceleration range: plus or minus 2.g.
6. Temperature range: minus 40 to plus 65 deg. C.
7. Protection: IP65.

D. Computerized remote monitoring system, including monitoring equipment and instruments, to monitor the effects of the natural phenomena on the buildings, mainly the wind and earthquake effects, the effect of man-made cyclic loads on large span floors and critical cantilever floors, and verify that the actual dynamic structural properties in terms of movements, vibrations, and accelerations are within the predicted range throughout the life span of the project. The monitoring scheme is concerned with the acquisition of measurements required to determine the magnitude of accelerations and vibrations of the tallest building, major parts of critical structures and long span slabs and beams, the tower or the selected critical floor slab, at bridge flexible decks such as cable stay and suspended bridges, using strain gauges, fiber optical sensors, 3D accelerators or accelerometers.

E. Selection of the locations of the points for strain measurement or 3D accelerators shall be agreed upon between the Engineer, the Designer, and the Contractor.

2.6 CORROSION SENSOR

A. Corrosion sensor is to consist of a set of individual sensors, especially designed to measure the ingress of corrosive agents through the concrete cover and detect early signs of corrosion at predefined locations

B. The sensors set is to be installed as recommended by individual or collective sensor manufacturer.

C. The sensor is to be supplied with all necessary wiring and interfaced with a data acquisition transmission hub for wireless connectivity to a cloud-based corrosion monitoring platform for real-time data access., and necessary attachments and power source.

D. Technical specifications shall satisfy the following as a minimum:

1. Measurement range: plus or minus 500mV.
2. Measurement Resolution: plus or minus 0.2mV.
3. Temperature range: minus 40 to plus 65 deg. C.
4. Protection: IP65 rated.

E. Computerized remote monitoring system, including monitoring equipment and instruments, to monitor the effects of the climate conditions and weathering exposure, in terms of steel corrosion, and implement reinstatement measures or intervene in an appropriate way to prevent the corrosion from reaching dangerous levels that jeopardize the stability and safety of the monitored structural elements. The monitoring scheme is concerned with the acquisition of measurements required to determine the magnitude of the steel corrosion of critical reinforced concrete member reinforcement, bridge structural elements that are subject to wetting and drying or at sea splash zones, or near the sea shoreline using integrated corrosion sensors.

F. Selection of the locations of integrated corrosion sensors shall be agreed upon between the Engineer , the Designer, and the Contractor.

2.7 CRACK WIDTH SENSOR

A. Crack-width sensor shall be especially designed for detection and measuring of cracks widths at concrete surface. types of sensors may vary from piezo-ceramic sensors, distributed fiber optic sensor based on optical frequency domain reflectometry, displacement/strain meters etc.

B. The sensor is to be applied as recommended by the manufacturer.

C. The sensor is to be supplied with all necessary wiring or hardware for wireless connectivity and necessary attachments and power source.

D. Technical specifications shall satisfy the following as a minimum:

1. Standard range: 25mm.
2. Resolution: 0.01 mm.
3. Temperature range: minus 40 to plus 65 deg. C.
4. Protection: IP65.

E. Computerized remote monitoring system, including monitoring equipment and instruments, to ensure that strains, and hence loads and crack-widths, are within the predicted range throughout the life span of the project, and implement reinstatement measures or intervene in an appropriate way to prevent further opening of cracks and related risk of corrosion of reinforcement and large deflections that jeopardize the stability, serviceability, and safety of the monitored structural elements. The monitoring scheme is concerned with the acquisition of measurements required to determine the magnitude crack-width at the critical concrete section, at the top of concrete section at continuous bridge decks at pier location, at the bottom face of the deck concrete section at midspans, at the face of abutment that is exposed to soil, using crack-width sensors.

F. Selection of the locations of the points for crack-width sensors shall be agreed upon among the Engineer, the Designer, and the Contractor.

PART 3 - EXECUTION

3.1 EQUIPMENT AND INSTRUMENTS

A. Equipment and instruments shall be installed as per the manufacturer's instructions and are to be calibrated and tested as appropriate. The monitoring scheme shall also include the installation, maintenance, replacement in case damaged, and observation of the equipment and instrumentation.

B. Observe, record, and analyze the readings to establish trends in movement and provide the Engineer with all recorded results. The Digital Twin platform shall be composed of a set of layers where data is captured, processed, stored, and made accessible to presentation layer interfacing directly with target audiences for monitoring and control.

C. All the monitoring devices, equipment, and wirings, shall be properly protected during construction from any source of damages, throughout their service life from environmental and other effects that would hinder their performance.

D. All gages, sensors, vibrating wires, and wiring shall be fixed as recommended by the manufacturer, using hot curing or cold curing adhesives, or by spot welding, on a surface that is treated, cleaned and prepared as recommended by the manufacturer. All equipment shall be protected from damage during all site activities such as installation of reinforcement bars, and pouring or compacting concrete. The equipment shall be tested before and after pouring of concrete and any damaged gages and sensors shall be reported and compensated at another location preapproved by the Engineer.

3.2 INSTRUMENTATION RECORDS AND REPORTING:

A. General Information: All records generated by the instrumentation, whether installation readings or monthly summaries, shall contain the following information:

1. Project name.

2. Contract name and number.
3. Instrument reference number and type.
4. Dates of installation, reading or summary.
5. Time of installation or reading.
6. Coordinates/designation of measurement point.
7. Personnel responsible.
8. Comments.

3.3 READINGS

A. For each measurement taken from an instrument or group of instruments, the values shall be recorded on a data sheet. The format of the output from each type of instrument shall be submitted to the Engineer for approval at least one week before commencement of readings. For readings that are recorded on a data logger, a record sheet shall be required indicating the references to the data stored[. A computer system including interfaces, plotter, printer and software shall be available to make data transfers, corrections of readings depending on temperature variations, listings and plots. The format of plotted results shall be submitted to the Engineer for approval.

B. Frequency of Measurement: The frequency of measurement shall be in accordance with the approved detailed program and method statements.

C. Anomalous Readings: Whenever sets of anomalous data are obtained from measurements, they shall be compared to previous sets of data. If anomalous readings are present which differ from the expected value or trend, then further readings shall be taken immediately and the Engineer shall be informed. If the anomalous values persist, then the Engineer shall be informed and an investigation carried out to explain the anomalous readings.

D. Submit to the Engineer each record sheet with necessary listings and graphs, make all captured, processed, and corrected data available to the Engineer in numerical and graphical formats within one working day of taking the readings unless otherwise directed by the Engineer.

3.4 MONITORING REPORT

A. Submit a monitoring report every month in case no anomalous readings are recorded. If irregular or anomalous observations are recorded, the Engineer shall be informed immediately. A proposal for the format of the report shall be submitted to the Engineer including all graphical presentations for approval at least one month before submission of the first report. Each monthly report is to include the following:

1. A description of the monitored works which have been in operation during the previous month.
2. Information on anomalous readings or corrective actions and factors which may influence measured data.
3. Observations/remarks.
4. Plan showing location of installed instruments.

END OF SECTION 013510

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SECTION 013513.16 - SPECIAL PROJECT PROCEDURES FOR DETENTION FACILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions and other Division 01 Specifications sections, apply to this Section.

1.2 SUMMARY

A. Section includes special procedures for coordination of detention work.

B. Detention work required by, but not specified in, this Section includes the following:

C. Related Requirements:

1. Division 01 Section 013200 "Construction Progress Documentation" for submitting schedules and reports, including Contractor's construction schedule.
2. Division 01 Section 014000 "Quality Requirements" for submitting test and inspection reports, and schedule of tests and inspections.

1.3 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Prepare and submit Project-specific coordination drawings, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved. Address the following, as applicable:

1. See individual Sections for specific coordination drawing requirements for products and equipment.
2. Show relationship of components indicated on separate Shop Drawings.
3. Show dimensions and clearances of interrelated detention work.
4. Provide templates and patterns.
5. Indicate required operation sequences of interrelated detention work.
6. Indicate required installation sequences.
7. Include information necessary for interface with other trades and building components.
8. See special construction, mechanical, plumbing, electrical, communications, and electronic safety and security Sections for specific coordination drawing requirements for required installations.

B. Qualification Data: For qualified Detention Specialist to demonstrate capabilities and experience. Include list of completed projects with project names and addresses; names, addresses, and telephone numbers of Engineers, Employers, and contractors; and date of occupancy by Employer.

C. Examination reports, documenting inspections of substrates, areas, and conditions.

D. Anchor inspection reports, documenting inspections of built-in and cast-in anchors.

E. Field quality-control reports.

F. Field quality-control certification, signed by Contractor and Detention Specialist.

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1.4 QUALITY ASSURANCE

A. Detention Specialist Qualifications: An experienced installer of detention products and equipment who has completed detention work installations similar in material, design, and extent to that indicated for Project and whose work has resulted in construction with a record of successful in-service performance.

1. Experience: No fewer than five completed detention projects (jails or prisons) that have been in operation for a minimum of five years.

a. Experienced in administration and supervision of detention work, including mechanical and electrical detention work, and integration of its various components.

1.5 DETENTION SPECIALIST

A. Responsibilities:

1. Detention work coordination.
2. Administrative procedures.
3. Examination.
4. Field quality control.
5. Demonstration.

1.6 DETENTION WORK COORDINATION

A. Coordinate detention work to ensure efficient and orderly installation and proper operation of each part of detention work. Coordinate detention work that depends on separate entities for proper installation, connection, and operation.

1. Develop special procedures required for coordination of detention work.
2. Coordinate installation of different detention components to ensure maximum accessibility for required maintenance, service, and repair.

B. Coordinate selection of detention products and equipment and ensure compatibility.

C. Verify qualifications of detention lock Installer specified in other Sections.

D. Coordinate installation of products furnished by Employer.

E. Assemble and coordinate Shop Drawings, work submittals, and applicable coordination drawings for detention work provided by separate entities responsible for detention work. Submit all submittal items required for each Detention Section concurrently unless partial submittals for portions of the Work are indicated on approved submittal schedule.

F. Detention Work Sub schedule: Coordinate sequencing and scheduling of detention work. Prepare a sub schedule to Contractor's Construction Schedule for detention work. Base sub schedule on preliminary construction schedule. Secure time commitments for performing critical construction activities from separate entities responsible for detention work.

1. Schedule construction operations in sequence required to obtain best results where installation of one part of detention work depends on installation of other components, before or after its own installation.
2. Coordinate sequence of detention work activities to accommodate tests and inspections.

G. Coordinate installation of anchorages and embedment’s for detention work. Obtain and distribute, to parties involved, setting drawings, templates, and directions for installing anchorages, including

sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

H. Coordinate type of security fasteners for detention work so no more than two different sets of tools are required to operate security fasteners for entire Project. Coordinate submittal of extra fasteners and tools for maintenance material submittals.

I. Check Shop Drawings of other related work to verify that adequate provisions are made for locating and installing detention work to comply with indicated requirements.

J. Coordinate temporary facilities and controls required by detention work.

K. Coordinate, schedule, and approve interruptions of existing utilities related to maintaining existing levels of security, including those necessary to make connections for temporary services.

1. Provide information necessary to adjust, move, or relocate existing detention utility structures affected by detention work.
2. Locate connection points to existing detention utility systems.

L. Coordinate protection of detention work.

M. Coordinate preparation of Project Record Documents for detention work and integrate information from entities responsible for detention work to form one combined record.

N. Coordinate preparation of operation and maintenance manuals for detention work and integrate information from entities responsible for detention work to form one combined record.

1.7 ADMINISTRATIVE PROCEDURES

A. Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of detention work. Such administrative activities include, but are not limited to, the following:

1. Preparation of detention work sub schedule for Contractor's Construction Schedule.
2. Installation and removal of temporary facilities and controls for detention work.
3. Delivery and processing of detention work submittals.
4. Preinstallation conferences for detention work.
5. Project closeout activities for detention work.

B. Notifications: Prepare memoranda for distribution to each party involved with detention work, outlining special procedures required for coordination of detention work. Include such items as required notices, reports, and attendance at meetings.

C. Coordination Meetings: Conduct coordination meetings specifically for detention work at weekly intervals. Coordination meetings are in addition to specific meetings held for other purposes, such as progress meetings and preinstallation conferences.

1. Attendees: In addition to representatives of Employer, Engineer, and Contractor, each subcontractor, supplier, installer, and other entity concerned with progress or involved in planning, coordination, or performance of detention work activities shall be represented at these meetings. All participants at meetings shall be familiar with Project and authorized to conclude matters relating to detention work.
2. Agenda: Review and correct or approve minutes of previous detention work coordination meetings. Review other items of significance that could affect progress of detention work. Include topics for discussion as appropriate to status of Project.

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a. Contractor's Construction Detention Work Sub schedule: Review progress since last detention work coordination meeting. Determine whether each schedule item is on time, ahead of schedule, or behind schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.
b. Schedule Updating: Revise Contractor's construction detention work sub schedule after each detention work coordination meeting where revisions to schedule have been made or recognized. Issue revised schedule concurrently with report of each meeting.
c. Review present and future needs of each entity present, including the following:

1) Detention work interface requirements.
2) Sequence of detention work operations.
3) Status of detention work submittals.
4) Access to detention work.
5) Temporary facilities and controls required by detention work.
6) Quality and work standards of detention work.
7) Change Orders for detention work.

3. Reporting: Record meeting results and distribute copies to everyone in attendance and to others affected by decisions or actions resulting from each meeting.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of detention work.

B. Examine roughing-in for embedded conduits and tubing and built-in anchors to verify actual locations of detention work connections before detention work installation.

C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of detention work.

D. Inspect built-in and cast-in anchors after installation but before connection to detention work to verify that anchor installations comply with requirements. Prepare inspection reports.

1. Where inspections indicate that anchors do not comply with specified requirements, reinspect after repairs or replacements are made.
2. Perform additional inspections to determine compliance of replaced or additional work. Prepare inspection reports.

E. Verify locations of detention work with those indicated on coordination drawings.

F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FIELD QUALITY CONTROL

A. Inspect installed detention work to verify compliance with requirements and that work is installed and connected according to the Contract Documents.

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B. Verify that wiring installation has been installed according to manufacturer's submittal and written installation requirements in electrical, communications, and electronic safety and security Sections.

C. Observe installation and startup checks of detention work according to manufacturer's written instructions.

D. Testing: After installing electrified and pneumatic detention work and after electrical circuitry has been energized and compressed-air system is functional, test for compliance with requirements.

1. When testing reveals detention, work does not comply with requirements, perform additional random testing to determine extent of noncompliance.
2. Where test results indicate that detention work does not comply with specified requirements, retest after repairs or replacements are made.
3. Perform additional testing and inspecting, at Contractor's expense, to determine compliance of replaced or additional work.

E. Inspection Reports: Prepare inspection reports and indicate compliance with and deviations from the Contract Documents.

1. Perform additional inspections to determine compliance of replaced or additional work.

F. Field Quality-Control Certification: Prepare field quality-control certification endorsed by Detention Specialist that states installed detention work complies with requirements in the Contract Documents.

3.3 DEMONSTRATION

A. Engage a factory-authorized service representative to train Employer's maintenance personnel to adjust, operate, and maintain detention products and equipment.

END OF SECTION 013513.16

SECTION 013520 - HEALTH, SAFETY AND ENVIRONMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions, the Employer Health, Safety and Environment Manuals, and other Division 01 Specifications sections, apply to this Section.

1.2 SUMMARY

A. Section includes:

1. This document mandates that the Contractor is fully responsible for managing all on-site Health, Safety, and Environmental (HSE) aspects, ensuring subcontractors and visitors' compliance.
2. The Contractor must provide essential safety facilities, conduct regular safety meetings, and oversee site security and traffic management.
3. Additionally, environmental protection measures and strict adherence to COVID-19 protocols are required.
4. The Contractor must develop and submit an HSE policy and a comprehensive Project Health, Safety, and Environmental Plan (PSHEP).
5. Compliance with ISO standards is mandatory, with the ultimate goal of achieving zero accidents and incidents on the project.

B. RELATED REQUIREMENTS

1. Division 01 Section 018113 - Sustainable Design Requirements

1.3 SCOPE OF WORKS

A. The Scope of Works as defined in the Tender Documents shall, in addition to whatever is described therein, include responsibility for the management and control of all health, safety and environmental (HSE) protection including all other related aspects of the project and the site. Such responsibility shall not be limited to the project but shall extend to the works and activities of all Appointed Contractors, including nominated subcontractor, suppliers and other persons working on or visiting the Site. This shall include, but not be limited to the following:

1. Provision of suitable welfare / safety and security facilities including drinking water, drainage, and sanitary disposal with sufficient ventilation and lighting where practical.
2. Safety consultation and the conduct of regular toolbox meetings.
3. Emergency procedures including fire-fighting facilities, appliances and training.
4. Suitable first-aid provisions including training of staff in first-aid skills and the process for emergency rescue.
5. Site access control and site security in coordination with the emergency procedures.
6. Site traffic management which shall include site access routes / circulation and speed restriction / directional signage.
7. Environmental management and protection measures against pollution and habitat preservation.
8. Site communication systems including suitable audible alarm system.
9. Housekeeping duties and waste management.

10. Provision and distribution of temporary electrical services including RCD protection for mains powered tools. (RCD, or Residual Current Device, is a life-saving device which is designed to prevent you from getting a fatal electric shock if you touch something live, such as a bare wire. RCDs offer a level of personal protection that ordinary fuses and circuit-breakers cannot provide).
11. Allocation of space and control of contractors' Site facilities and storage areas.
12. Organisation of Site craneage, hoisting facilities and all lifting operations.
13. Provision and distribution of temporary utilities required for all works on the Project.
14. Organisation of final clean-up of the works prior to completion and handover.
15. Suitable storage and segregation of flammable materials.
16. Adherence to COVID safety requirements, protective gear, and screening of personnel as may be necessary further to the Employer's requirements and local authority regulations. This shall include, without limitation, routine PCR test, daily temperature checks, and implementation of social distancing measures. Contractor to provide evidence for all employees and workers on site vaccination program and its implementation.

B. In fulfilment of the above obligations and responsibilities the provisions and proposals of all Associated Contractors and Nominated Subcontractors including any others already working on the Site must be reviewed. Such provisions and proposals must be integrated into the HSE plan to ensure the overall management and control of the HSE aspects, facilities and activities of the Project on the Site are as defined above. Consult and coordinate with any Associated Contractors, etc. and identify and correct any deficiencies in their provisions and proposals relative to those functions of control and management of the HSE procedures on the Project and Site.

C. The Scope of Works shall in addition to the responsibility for the management and control of all occupational health, safety and environmental protection requirements, include all other related aspects of the Project and the Site. Such responsibility shall not be limited to the Project but shall extend to the works and activities of all Appointed Contractors, including nominated subcontractor, suppliers and other persons working on or visiting the Site.

1.4 HEALTH, SAFETY AND ENVIRONMENT INFORMATION

A. Formulate an HSE (Health, Safety and Environmental) policy. and submit to the Employer's representative for review and approval. The policy must be displayed at conspicuous locations on the worksite in English and any language understood by a significant number of the construction workforce.

B. Submit a Project Safety Health Environmental Plan (PSHEP) within fifteen (15) days after commencement of the Work, or as per agreed time frame. The issue of the Letter of Acceptance which should describe the Contractor's organization and resources which is proposed to be deployed; and undertake to safeguard the health and safety of operatives including those of associated contractors, nominated subcontractors and general visitors to site, including the employees of the Employer and the Engineer. All necessary local and international regulations and requirements must be included in the plan.

C. The Project, Safety, Health, and Environment Plan (PSHEP) shall include, but not limited to:

1. A copy of the health and safety policy, statement, proposals and commitment.
2. Records of training and training policies.
3. The numbers and type of staff to be responsible for health and safety on this Project with details of their qualifications and duties, and how the responsibility for health and safety management is devolved to the workforce.
4. Program of Implementation.
5. Roles and Responsibility of all involved within the project including a structured organogram.
6. Project specific risk assessments and method statements including assessments for controlling and storing hazardous substances (COSHH – Control of Substances Hazardous to Health).

7. Emergency arrangements for fire, explosions, and terrorist bomb threats that present life threatening situations.
8. Emergency preparedness and response including emergency rescue procedures.
9. Measures to reduce occupational health including noise, vibration, dust.
10. Details on the procedure for monitoring and measurement, workplace inspections, equipment inspections, health surveillance, incident investigation, corrective and preventative action, and records.
11. High risk working procedures covering excavations, work at height, confined space, hot works, ensuring that a suitable permit to work system is enforced.
12. Information regarding the selection and use of appointed subcontractors.
13. Information regarding the selection and use of plant and work equipment.
14. A strategic HSE induction program that entails all the above.
15. Contractor's Covid 19 management plan.

1.5 HEALTH, SAFETY AND ENVIRONMENT (HSE) PERSONNEL QUALIFICATIONS

A. The Contractor shall engage qualified professionals to complete requirements and processes related to HSE and inclusive of the specific site safety staff qualifications, requirements and processes required for acceptance ofthe Contractor's HSE applicants by the Employer.

B. The Contractor shall have a sufficient number of HSE personnel on-site to perform the day-to-day HSE site activities. as required by the Employer.

C. The Contractor shall submit HSE Personnel CVs' for the Employer's approval. Moreover, HSE Managers, Senior HSE Managers and senior HSE Representatives' appointment and qualifications would need to acquire approval from the Employer.

D. The Contractor's HSE Manager / Representative must report directly to Contractor's senior management according to their Corporate Organization.

E. The mandatory and desired qualifications criteria for the HSE staff shall all comply with approved and adopted HSE Manual.

1.6 HEALTH, SAFETY AND ENVIRONMENT RESPONSIBILITIES OF THE CONTRACTOR

A. Accept responsibility for overall control, coordination, supervision and administration of the whole of the Project in respect of health and safety management, including all associated contractors, nominated subcontractors, suppliers and visitors.

B. Prior to mobilization and commencement of site activities, the employer HSE manager will arrange a pre-construction meeting with the Contractor's project manager and HSE's representative to establish the Employer's HSE project requirements. Arrange and monitor a program for health, safety and environmental management with each associated contractor, and subcontractor, and supply all information as necessary for the safe coordination of all work activities relative to the health and safety on the Site.

C. Prepare a Health and Safety Program for the Project, covering times of working, partial handovers etc. and ensure this program considers the work of all associated contractors and subcontractors, whether nominated or otherwise.

1. In addition to the constant management and supervision of the Project and Site in respect of health and safety provided by the Contractor's person in charge, ensure all significant or hazardous / risky types of work are under the close control of competent safety supervisors to ensure maintenance of satisfactory safety standards
2. The Employer and the Engineer have set the following health and safety goals for the project in pursuit of Target Zero**:**

a. Zero Accident
b. Zero Incidents

D. Engage suitably competent and adequately resourced staff and ensure that associated contractors do likewise to their subcontractors by ensuring that HSE targets are met, and that sufficient training is reviewed, and that reports on a daily, weekly, monthly, six monthly and annual bases in respect of health and safety management are made available to the Employer's and the Engineer's safety personnel. Always ensure that all the workers have been provided with suitable health and safety information, instruction, and training in respect to their work activities.

E. Ensure the involvement of the entire workforce, as subcontractors and suppliers may need to make special arrangements for workers with different languages. This could include providing translation, using interpreters or replacing written notices with clearly understood symbols or diagrams.

F. Comply with all current legislation, regulations and local standards, both national and international i.e. ISO 45001:2018, ISO 14001:2015, and define how the requirements of these documents are being met. Ensure copies of these documents are readily available either in hard copies or for access via computer links.

G. Adequately safeguard the Site, its works, products, materials, plant and any existing buildings or structures from damage and theft. Take all reasonable precautions to prevent unauthorised access to the Site, the Works and any adjoining properties. Prepare and enforce all necessary site rules, provide relevant parts of the HSE plan and other information to subcontractors and suppliers in sufficient time for them to plan their work.

H. Take the reasonable steps to prevent access by unauthorized persons to the Site by displaying suitable signage around the site perimeter and main gate entrance. Only persons who are explicitly authorized, individually or collectively, should be allowed access. The authorization may cover the whole site, or to be restricted to certain areas. Authorized people should have relevant site rules explained to them and undertake any necessary site induction and should comply with site rules and co-operate with the stated requirements. Some authorized visitors may need to be supervised or accompanied while on site or when visiting specific areas.

I. Provide specific information about the risks associated with the Site and the arrangements made for their control. A site induction is not intended to provide general health and safety training, but it should include a site-specific explanation of senior management commitment to health and safety outlining the project, the individual's immediate line manager and any other key personnel, and any site-specific health and safety risks. In general, this site induction shall address access, transportation and storage of hazardous substances (COSHH), site contamination, manual handling, control measures on the site, arrangements for first aid, arrangements for reporting accidents and other incidents, details of any planned training, such as 'toolbox' talks, arrangements for consulting and involving workers in health and safety and information about the individual's responsibilities for health and safety.

J. Ensure that adequate measures are implemented on-site to ensure the stability and structural integrity of the Works during construction and provide support as necessary. Prevent overloading of structures. Check the adequacy and structural integrity and stability of all erected scaffolding and other temporary "work access" systems and sign-off prior to use.

1. Existing buildings or structures adjacent to the Site will be occupied and / or used during the Contract.
2. Ensure the works are carried out safely and without inconvenience or nuisance and without danger to occupants, users, equipment, or vehicles and provide for the safe operation of the existing facilities.
3. Passes may be required for access to all parts of the Site. If required by the Employer, submit a list of the names of all personnel requiring passes together with any other related information the Employer or Engineer may reasonably require. Ensure passes are carried at all times and returned to the Employer when requested and in any case on cessation of the work of the pass holder.

4. Ensure the interaction of local residents and pedestrians is minimized at all times and that contractors' vehicles do not obstruct access to property and residential areas.

K. Comply with all rules and regulations listed within the Tender and Contract Documents and the 'Site Safety Plan' issued with those Documents. Ensure these rules and regulations are made known to all employees and visitors at safety inductions, and that they are displayed where all may see them.

L. Comply with Occupational Health and Safety Management Standard ISO 45001:2018 and ISO 14001:2015 standards.

M. Inform the Employer and the Engineer in advance of all safety provisions and procedures that will require compliance from the Employer's and the Engineer's representatives when visiting the site.

N. Work notification / permit-to-work procedures will operate for all work carried out: Permits must be obtained in advance where deemed necessary from the Employer and / or the relevant authorities having jurisdiction: Ensure that a permit-to-work system is also in place for hazardous activities that may occur within the Site boundary as opposed to operational areas, this may include activities such as, but not restricted to:

1. Hot Work
2. Confined Spaces
3. Electrical (Live Working)
4. Excavations
5. Lone Working
6. Demolitions / Explosions.
7. Lifting Operations.
8. Etc.

O. Take all reasonable precautions to prevent pollution of the Site, its works, the adjacent facilities, the surrounding drainage and water supplies and the general environment. Provide within the Construction Project Health, Safety and Environment Plan (CPHSEP) a detailed method statement as to how this requirement will be undertaken and monitored including frequency of checks etc.

P. Remove waste, rubbish, debris, surplus materials, and spoil regularly and keep the Site and works clean and tidy. Ensure that all waste, rubbish, dirt and other residue are removed from voids and cavities in the construction before closure. Ensure that all roadways and pedestrian areas are always kept clean and clear and free from debris.

Q. Take all necessary measures to prevent personal injury, death and damage to the Works or other adjacent property or equipment from fire or explosion:

1. DO NOT: allow the burning of materials arising from the works on Site.
2. Designate safe "smoking" areas on the Site and ensure that smoking is prohibited in other areas.
3. Ensure suitable fire-fighting equipment is available on Site
4. Undertake frequent emergency drills and regular inspections

R. Take all necessary precautions to avoid excessive electromagnetic disturbance of apparatus outside the Site.

S. During work and inspections of all types provide temporary lighting, the intensity and direction of which closely resembles that provided by the permanent installation.

T. Install, use and store construction laser equipment in accordance with the manufacturers' instructions. Use either Class 1 or Class 2 laser equipment ensuring that the laser beam is not set at eye level, and that the beam is terminated at the end of its useful path.

U. Adequately maintain roads and footpaths both around the Site and adjacent to the Site and keep clear of dust, mud and debris.

V. Propose methods of work for effects on adjacent structures inside and outside the Site boundary. Ensure the provision and maintenance during the execution of the works of all incidental shoring, strutting, needling and other supports and dewatering installations as may be necessary to preserve the stability of existing structures on the Site or adjoining, that may be endangered or affected by the works. Support existing structure as necessary during cutting of new openings or replacement of structural parts. Monitor adjacent structures and immediately report excessive movement to the Engineer. Allow for the removal of supports only after new work is strong enough to support the existing structure. Prevent overstressing of completed work when removing supports.

W. Define and produce an overall Site-specific Project, Safety Health, and Environment Plan (PSHEP) for the Project, for review and approval by the Employer and the Engineer. This plan should not be generic in nature and must build on the information provided within the Tender and Contract Documents, specifically the 'Project Site Safety Plan' issued.

1. The plan must be prepared, submitted for review prior to the start of construction activities on the Works of the Contract and be available for review at any time during the construction period. It should be implemented and managed as an operational document throughout the Project and available for all who may be affected by its contents.
2. It must be clear in its purpose, well structured, relevant and easy for associated contractors and others to understand. It should not contain irrelevant material.
3. The plan should clearly identify the correct methods of operation and any associated risks therein.

X. Provide all own staff and all the Employer's and Engineer's staff and visitors for the duration of Project (including Mobilization & Defects Notification Period) with all PPE and other safety-related items sufficient for the construction of the Project as per the Health and Safety Plan and the Engineer's instructions in this respect.

1.7 HEALTH, SAFETY AND ENVIRONMENT PLAN

A. A specific Project , Safety, Health and Environment Plan (PSHEP) must be developed and submitted to the Employer's HSE Representative for review and approval prior to commencing the work within fifteen (15)] days after commencement of the Work. All necessary local and international regulations and requirements must be included in the plan.

B. The plan must include detailed policies, procedures and regulations that will ensure compliance with the contractor provisions when implemented.

C. The plan must Comply with any additional safety security requirements suggested by the Employer's Representative and as required by the authorities and international standards.

D. The HSE Plan must promote the prevention of injury, occupational hazard / illness and property damage.

E. Maintain a safe, hazard-free workplace for personnel, visitors and the public.

F. Review the HSE Plan at regular intervals and update it as required, considering changes on-site during the construction phases and, at a minimum, annually. The contractor must retain records of revisions.

G. Ensure site security compliance per agreement with the Employer which will be monitored for effective implementation by the Employer's Representative.

H. If at any time the HSE Plan is, in the employer Representative's opinion, insufficient or requires revision ormodification to ensure that the health and safety of all personnel is met, the Employer Representative may instruct the Contractor to revise the plan and the Contractor must submit the revised plan to the Employer Representative for review within an agreed timeframe.

I. The Contractor is obligated to perform their work using safe working methods and to comply with the Project SHE Plan consistently.

J. The plan is to follow the Employer Health, Safety and Environment Manuals. and to include as a minimum, the following:

1. Description of the Project

    a. Project Description and Program details, including health and safety management details.

2. Details of all Associated Contractors, including names and contact numbers of those responsible for health and safety affairs, type of work to be undertaken, etc.
3. Content & extent of all documents are to include but not restricted to the following:

    1. Locations and contact numbers of all emergency services
    2. Operational systems
    3. Plans (traffic management, emergency arrangements, transport logistics)
    4. Location of existing records and plans that are relevant to health and safety on site, including information about existing structures and buried services
    5. Method statements
    6. Risk assessments
    7. Inspection reports
    8. Training
    9. Emergency response and rescue information
    10. Partial and comprehensive evacuation plans

K. Arrangements for communication and management of the Works include:

a. Regular liaison between all persons and entities on site to discuss design information. Discussions on design changes during the project should be made available to all other parties on Site, particularly in respect of health and safety management, its operation and how information is to be disseminated to the other parties involved on the Project.
b. Monitoring and review health and safety performance and operational management systems.
c. Regularly reviewing the management structure and responsibilities related to health and safety goals for the project and arrangements for monitoring and review of health and safety performance.
d. Consultation with the workforce in respect of health and safety issues, taking in to account the diversity of cultures and languages in use on the Site. Define how the culture and language issues will be dealt with both at operational and management level.
e. The exchange of information between all parties particularly the control of and transfer of health and safety information between all types of contractors and all levels of employees on Site, and ensuring it is understood.
f. The selection and control of contractors, and sub-contractors, and the liaison methods in place in respect of health and safety.
g. The security of the defined Site, including access and egress controls, and site rules.
h. Site safety inductions and orientation for all employees and visitors, and further training of all employees in respect of activities requiring specialist health and safety training. These arrangements should indicate how the Contractor ensures all employees have understood their health and safety duties (tests and reviews).
i. The provision of welfare facilities and first aid at all times of activity.
j. Arrangements for recording, reporting and investigation of accidents and incidents, including application of systems for future prevention of accidents and incidents and near misses.

k. The production, reviewing, approval and monitoring of application of risk assessments and method statements and the process whereby these documents are providing for review by the necessary authorities.
l. The setting of, monitoring, inspection and application of both contractual and additional Site rules, including a disciplinary system for non-compliances.
m. Fire and emergency procedures, including call out procedures for out-of-hours incidents / accidents / dangerous occurrences.
n. The establishment of the need for personal protective equipment, and or clothing throughout the Site, including procedures for monitoring non-compliances with these procedures and a disciplinary system.
o. Inspection, monitoring and review of activities throughout the Project, including liaison systems between Associated Contractors, etc. affected by these activities at both management and operational levels.
p. The provision of necessary location and direction signage during construction, required to identify clearly all parts of the Site and the Project, in particular for the benefit of Employer and visitors. Such signage shall be modified and updated on a regular basis to reflect the progress and development of works on Site.

L. Arrangements for controlling significant Site risks:

a. The risks detailed may not be all of the significant risks associated with the work processes and are indicative of those that may become apparent on the Site. Identify significant hazards and undertake a risk assessment of those hazards based on the systems detailed within the Tender and Contract Documents, and ensure all associated contractors and subcontractors utilize the same system. These risks should, where necessary, be subject to the production of method statements for reviewing by the Engineer and any authority, having jurisdiction. The following risks must also be included within the Project Safety, Health, and Environmental Plan (PSHEP):

1. Services, including water, electricity and gas, including overhead power lines for both temporary and permanent electrical installations
2. Working at height including prevention of falls and falling materials
3. Ground conditions
4. Large numbers of personnel
5. Work with or near fragile materials
6. Control of lifting operations (cranes, hoists, mobile elevating working platforms)
7. The maintenance and use of plant and equipment
8. Unstable ground conditions
9. Unstable structures both during construction and demolition
10. Demolition and dismantling
11. Traffic routes and segregation of vehicles and pedestrians, particularly personnel movement around site
12. Storage and use of hazardous materials (COSHH)
13. Adjacent land use (operational airport, nearby highway)
14. Fuel storage
15. Fire and explosion
16. Manual handling and associated issues
17. Reducing noise and vibration
18. Dust
19. Radioactive isotopes and X-rays
20. Flying objects and debris (FOD)
21. Working below ground and at depth
22. Confined spaces, including wells, underground earthworks, and tunnels
23. Standing water (dewatering processes)
24. Weather (wind, rain, thunderstorms, heat, humidity etc.)
25. Transport of construction materials
26. Storage and removal of waste
27. Temporary works (scaffolding, formwork, false work etc.)
28. Stability of structures including temporary structures and existing unstable structures

29. Violent behaviour
30. Delivery and removal of materials (including waste) and any work equipment considering any risks to the public, for example during access and egress to and from the Site
31. Occupational health risks, including manual handling and the use of hazardous substances (COSHH) where there is a need for health monitoring which will include reducing noise and vibration levels, working with ionising radiation and exposure to UV radiation (from the sun)
32. Water, where there is a risk of drowning
33. Other specified or identified risks

M. Method Statements for inclusion within the submitted Health, Safety and Environment Plans

a. In order to ensure that the submitted Project Health, Safety and Environment Plan (PHSEP) is project specific, a number of method statements must be supplied with and as the first stage of this plan, for review prior to commencement of construction on the Works of the Contract. These statements must follow the format detailed within the Tender and Contract Documents.

b. Method Statements shall fully describe and define the construction task and activity and must be submitted to the Engineer for review.

c. Each method statement shall, notwithstanding the requirements of the Tender and Contract Documents, will be written clearly to enable those doing the work to understand fully the details of the specific task, and the necessary health and safety requirements and must contain the following details where applicable:

a. Heading & Documentation Layout

1) Company Details - Address, Tel & Fax No's & E-mail
2) Title - What task(s)? + Ref No
3) Employer / Main Contractor(s)
4) Location of Works - General & Specific
5) Name of Company Contact + Phone No
6) Start Date & Duration of Works
7) Page & Paragraph Numbers

b. Description

1) General Scope of Works
2) Sequence - Explanation of Operation(s) / Process('s)

c. Resources

1) No of Personnel - for Task(s) / Operation / Process
2) Plant / Equipment / Tools to be used (+ Task Lighting?)
3) Transportation - Delivery & Collection Procedure(s)
4) Materials - Delivery to Area(s) of Work(s) & Storage

d. Control Measures to be used

1) Induction Training + Task Specific Training
2) Permits - Hot Works, Areas of High Risk
3) Hazard Signage - Specific Tasks as required
4) Access & Egress - Security / Signing In & Out

e. PPE (Personal Protective Equipment) and Welfare & Temp Accommodation Facilities

1) Type(s) of PPE to be used
2) Office (if required), Canteen, Rest Room, Drying Room

f. Emergency Arrangements

1) First Aider - Name, Position + Contact Details
b. First Aid Kit - Availability & Location
c. Special / Specific Rescue Procedures required

g. Protective Systems / Measures

1) Temp Systems - What / Who provided by? *(Fire Points, Elec, Water)*
2) Safeguards - Barriers, Fencing, Screens, etc.
3) Others Site Personnel / Occupiers / Visitors / Public

h. Risk Assessment & Noise Monitoring

1) Individual Task(s) + Related Hazards
2) Persons affected
3) Risk Rating - Probability x Consequence
4) Control Measures - Each Individual Task(s)
5) Assessor's - Name, Position + Signed & Dated
6) Noise Monitoring Required for Task(s)?

i. COSHH Assessment + Storage & HF Liquids & Gases

1) Relevant Safety Data Sheets (Within 5 Years of issue) for all Hazardous Substances / Materials / Liquids / Gases
2) Designated Storage for COSHH items and Gas Cylinders

j. Monitoring & Compliance

1) Supervisor - Name, Position + Contact Details
2) Assessor's - Name, Position + Signed & Dated.

k. This does not however exclude the duties to manage health and safety on the Site after acceptance by the Employer and the Engineer of the plan; thus, the development and inclusion of further method statements for hazardous activities is a fundamental requirement.

d. The Method Statements required are detailed below:

1. Security of the Site
2. Health and Safety Induction Processes, including the means of dealing with the cultural and language issues
3. Segregation / protection of areas where work is in progress (Fencing)
4. Control of noise
5. Control of dust
6. Traffic management
7. Work at height
8. Confined spaces
9. Buried and overhead services
10. Hazardous substances (COSHH)
11. Fire Prevention
12. Working over / adjacent to watercourses
13. Housekeeping
14. Electrical Installations (including temporary installations)
15. Material storage
16. Excavations
17. Piling Works
18. Contaminated Land
19. Welfare

20. Lifting operations
21. Selection and use of PPE

1.8 MANAGEMENT OF RESIDUAL RISK

A. The purpose of this section is to include adequate information about the structure, or materials used which might affect the health or safety of anyone carrying out construction or cleaning work or of anyone who may be affected by such work.

B. Ensure the production and collation of information for management of the residual risks that remain to be dealt with by the Employer as a result of the design and construction process; this should include as a minimum the following:

1. Future maintenance.
2. Cleaning.
3. Access Requirements / Restrictions.
4. Working space requirements.
5. Details of key structural principles, including safe working floor and roof loads.
6. Details of construction methods and materials, including dated data sheets, which may present residual hazards with respect to cleaning, maintenance, repair, renovation or demolition.
7. General maintenance instructions including access provision and information about equipment provided for cleaning and maintaining the building fabric.
8. The nature, location and markings of utilities and services, including emergency and fire-fighting equipment.
9. Details of hazard substances (COSHH) associated with the materials used in the construction.
10. Any residual hazards which remain and how they have been dealt with (for example surveys or other information concerning asbestos; contaminated land; water bearing strata; buried services etc.).
11. Key structural principles (for example, bracing, sources of substantial stored energy – including pre- or post-tensioned members) and safe working loads for floors and roofs, particularly where these may preclude placing scaffolding or heavy machinery there.
12. Hazardous materials (COSHH) used (for example lead paint; pesticides; special coatings which should not be burnt off etc.).
13. Information regarding the removal or dismantling of installed plant and equipment (for example any special arrangements for lifting, order or other special instructions for dismantling etc.).
14. Health and safety information about the equipment provided for cleaning or maintaining the structure.
15. Information and as-built drawings of the structure, its plant and equipment (for example, the means of safe access to and from service voids, fire doors and compartmentalisation etc.).

C. The Management of Residual Risk Plan must be provided in a format and with sufficient detail that the Employer and the Engineer can identify hazards and risks for the Employer's employees and future contractors to enable work to be carried out safely without the requirement to undertake searches, surveys, etc. that may prove hazardous in themselves.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 013520

SECTION 014000 - QUALITY REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions and other Division 01 Specifications sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspection services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.

1. Specific quality-assurance and quality-control requirements for individual work results are specified in their respective Specification Sections. Requirements in individual Sections may also cover production of standard products.
2. Specified tests, inspections, and related actions do not limit Contractor's other quality-assurance and quality-control procedures that facilitate compliance with the Contract Document requirements.
3. Requirements for Contractor to provide quality-assurance and quality-control services required by the Engineer, the Employer, Commissioning Authority, Construction Manager, or authorities having jurisdiction are not limited by provisions of this Section.

C. Related Requirements:

1. Division 01 Section "Construction Progress Documentation" for developing a schedule of required tests and inspections.
2. Specifications sections in addition to Division 01 Sections for specific test and inspection requirements.
3. Specification sections in addition to Division 01 for specific mock-up requirements not indicated in this Section.
4. Specification sections related to the functionality and efficiency of the executed systems.

1.3 DEFINITIONS

A. Experienced: When used with an entity or individual, "experienced," unless otherwise further described, means having successfully completed a minimum of five (5) previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

B. Field Quality-Control Tests and Inspections: Tests and inspections that are performed on-site for installation of the Work and for completed Work.

C. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, subcontractor, or sub-subcontractor, to perform a particular construction operation, including installation, erection, application, assembly, and similar operations.

1. Use of trade-specific terminology in referring to a Work result does not require that certain construction activities specified apply exclusively to specific trade(s).

D. Mockups: Physical assemblies of portions of the Work constructed to establish the standard by which the Work will be judged. Mockups are not Samples.

1. Mockups are used for one or more of the following:

a. Verify selections made under Sample submittals.
b. Demonstrate aesthetic effects.
c. Demonstrate the qualities of products and workmanship.
d. Demonstrate successful installation of interfaces between components and systems.
e. Perform preconstruction testing to determine system performance.

2. Product Mockups: Mockups that may include multiple products, materials, or systems specified in a single Section.
3. In-Place Mockups: Mockups constructed on-site in their actual final location as part of permanent construction.
4. Laboratory Mockups: Full-size physical assemblies constructed at testing facility to verify performance characteristics.
5. Integrated Exterior Mockups: Mockups of the exterior envelope erected separately from the building but on Project site, consisting of multiple products, assemblies, and subassemblies.
6. Room Mockups: Mockups of typical interior spaces complete with wall, floor, and ceiling finishes, doors, windows, millwork, casework, specialties, furnishings and equipment, and lighting.

E. Preconstruction Testing: Tests and inspections performed specifically for Project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria. Unless otherwise indicated, copies of reports of tests or inspections performed for other than the Project do not meet this definition.

F. Product Tests: Tests and inspections that are performed by a testing agency qualified to conduct product testing and acceptable to authorities having jurisdiction, to establish product performance and compliance with specified requirements.

G. Source Quality-Control Tests and Inspections: Tests and inspections that are performed at the source (e.g., plant, mill, factory, or shop).

H. Testing Agency: An entity engaged to perform specific tests, inspections, or both. The term "testing laboratory" has the same meaning as the term "testing agency."

I. Quality-Assurance Services: Activities, actions, and procedures performed before and during execution of the Work, to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

J. Quality-Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work, to evaluate that actual products incorporated into the Work and completed construction comply with requirements. Contractor's quality-control services do not include contract administration activities performed by the Engineer or Construction Manager.

1.4 DELEGATED DESIGN SERVICES

A. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of Contractor by the Contract Documents, provide products and systems complying with specific performance and design criteria indicated.

1. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to the Engineer.

B. Delegated Design Services Statement: Submit a statement signed and sealed by the responsible design professional, for each product and system specifically assigned to Contractor to be designed or certified by a design professional, indicating that the products and systems are following performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.5 CONFLICTING REQUIREMENTS

A. Conflicting Standards and Other Requirements: If compliance with two or more standards or requirements is specified and the standards or requirements establish different or conflicting requirements for minimum quantities or quality levels, inform the Engineer regarding the conflict and obtain clarification prior to proceeding with the Work. Refer conflicting requirements that are different, but apparently equal, to the Engineer for clarification before proceeding.

B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified is the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to the Engineer for a decision before proceeding.

1.6 ACTION SUBMITTALS

A. Mockup Shop Drawings:

1. Include plans, sections, elevations, and details, indicating materials and size of mockup construction.
2. Indicate manufacturer and model number of individual components.
3. Provide axonometric drawings for conditions difficult to illustrate in two dimensions.

1.7 INFORMATIONAL SUBMITTALS

A. Contractor's Quality-Control Plan: For quality-assurance and quality-control activities and responsibilities.

B. Qualification Data: For Contractor's quality-control personnel.

C. Contractor's Statement of Responsibility: When required by authorities having jurisdiction, submit copy of written statement of responsibility submitted to authorities having jurisdiction before starting work on the following systems:

1. Seismic-force-resisting system, designated seismic system, or component listed in the Statement of Special Inspections.
2. Primary wind-force-resisting system or a wind-resisting component listed in the Statement of Special Inspections.

D. Testing Agency Qualifications: For testing agencies specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by the authority having jurisdiction.

E. Schedule of Tests and Inspections: Prepare in tabular form and include the following:

1. Specification Section number and title.

2. Entity responsible for performing tests and inspections.
3. Description of test and inspection.
4. Identification of applicable standards.
5. Identification of test and inspection methods.
6. Number of tests and inspections required.
7. Time schedule or time span for tests and inspections.
8. Requirements for obtaining samples.
9. Unique characteristics of each quality-control service.

F. Reports: Prepare and submit certified written reports and documents as specified.

G. Permits, Licenses, and Certificates: For Employer's record, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents established for compliance with standards and regulations bearing on performance of the Work.

H. Delegated-Design Submittal: In addition to Shop Drawings, Product Data, and other required submittals, submit a statement, signed and sealed by the responsible design professional, for each product and system specifically assigned to the Contractor to be designed or certified by a design professional, indicating that the products and systems follow performance and design criteria indicated. Include list of codes, loads, and other factors used in performing these services.

1.8 CONTRACTOR'S QUALITY-CONTROL PLAN

A. Quality-Control Plan, General:

1. Submit quality-control plan within ten (10) days of Notice of Award, and not less than five (5) days prior to preconstruction conference. Submit in format acceptable to the Engineer. Identify personnel, procedures, controls, instructions, tests, records, and forms to be used to carry out Contractor's quality-assurance and quality-control responsibilities and to coordinate Employer's quality-assurance and quality-control activities. Coordinate with Contractor's Construction Schedule.
2. Notify the Engineer or his authorized representative in writing of any proposed change to the Quality Control Plan. Any proposed changes must not be implemented until prior approval has been received from the Engineer.
3. The Engineer shall have the right to perform quality audits to verify adherence of the Contractor and his sub-contractors or suppliers to the Quality Control Plan upon providing the Contractor with a 24-hour notice.

B. Contents of Quality Control Plan shall include as a minimum:

1. Identify the quality policy, methodology and framework adopted by the Contractor.
2. Identify quality objectives and define KPIs measured and compared against these objectives.
3. Include a quality organization chart showing the personnel; describe the quality organization including major reporting lines and relationships within and external to the organization. Authorities, duties and responsibilities within the said organization shall be stated.
4. Describe all quality assurance and quality control activities to be performed in relation to the works. Identify controls, key performance indicators and trend analysis mechanisms to be used to carry out Contractor's quality-assurance and quality-control responsibilities
5. Include procedures, processes and forms to be used and document control procedures.
6. Describe methods proposed to control the use of the various design documents, shop drawings, procedures, etc. to assure that only the latest reviewed documents are used and are distributed to the individuals performing the Work. Recall of documents which have been superseded or revised shall be implemented. Describe the process used to determine what submittals are required by the Contract and the system used to track these submittals and their current status.

7. Describe method of documenting quality control operations, inspections and testing. This shall include how various records originated and how they are maintained, received, filed, protected, and authenticated. Quality records required for submittal to the Engineer shall be described.
8. Describe methods for accomplishing quality control inspections addressing the how, what, where, when and why of these inspections, including that for subcontractor's work. Include as a minimum, three phases of inspection for all definable phases of the Works.
9. Identification and description of all mock-up items.
10. Detailed listing by Specification Section and paragraph designating all Quality Control requirements and tests to be performed and their frequency. Further indicate which tests will be performed by technicians or by an approved testing laboratory.
11. Methods to be employed when any Work is found not to meet Technical Specifications and the means to be implemented to document the items (non-conformance reports) and provide resolution.
12. A matrix of all Contract and Technical Specification requirements to enable monitoring of all items from start until acceptance and completion. This is to facilitate Contract closeout.

C. Quality-Control Personnel Qualifications: Engage qualified personnel trained and experienced in managing and executing quality-assurance and quality-control procedures similar in nature and extent to those required for Project.

D. Submittal Procedure: Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.

E. Testing and Inspection: In quality-control plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:

1. Contractor-performed tests and inspections, including subcontractor-performed tests and inspections. Include required tests and inspections and Contractor-elected tests and inspections. Distinguish source quality-control tests and inspections from field quality-control tests and inspections.
2. Special inspections required by authorities having jurisdiction and indicated on the Statement of Special Inspections.
3. Employer-performed tests and inspections indicated in the Contract Documents, including tests and inspections indicated to be performed by Commissioning Authority.

F. Continuous Inspection of Workmanship: Describe process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring the Work into compliance with standards of workmanship established by Contract requirements and approved mockups.

G. Monitoring and Documentation: Maintain testing and inspection reports, including log of approved and rejected results. Include Work the Engineer has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming Work into compliance with requirements. Comply with requirements of authorities having jurisdiction.

1.9 REPORTS AND DOCUMENTS

A. Test and Inspection Reports: Prepare and submit certified written reports specified in other Sections. Include the following:

1. Date of issue.
2. Project title and number.
3. Name, address, telephone number, and email address of testing agency.
4. Dates and locations of samples and tests or inspections.
5. Names of individuals making tests and inspections.

6. Description of the Work and test and inspection method.
7. Identification of product and Specification Section.
8. Complete test or inspection data.
9. Test and inspection results and an interpretation of test results.
10. Record of temperature and weather conditions at time of sample-taking and testing and inspection.
11. Comments or professional opinion on whether tested or inspected Work complies with the Contract Document requirements.
12. Name and signature of laboratory inspector.
13. Recommendations on retesting and reinspecting.

B. Manufacturer's Technical Representative's Field Reports: Prepare written information documenting manufacturer's technical representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, telephone number, and email address of technical representative making report.
2. Statement on condition of substrates and their acceptability for installation of product.
3. Statement that products at Project site comply with requirements.
4. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
5. Results of operational and other tests and a statement of whether observed performance complies with requirements.
6. Statement of whether conditions, products, and installation will affect warranty.
7. Other required items indicated in individual Specification Sections.

C. Factory-Authorized Service Representative's Reports: Prepare written information documenting manufacturer's factory-authorized service representative's tests and inspections specified in other Sections. Include the following:

1. Name, address, telephone number, and email address of factory-authorized service representative making report.
2. Statement that equipment complies with requirements.
3. Results of operational and other tests and a statement of whether observed performance complies with requirements.
4. Statement of whether conditions, products, and installation will affect warranty.
5. Other required items indicated in individual Specification Sections.

1.10 QUALITY ASSURANCE

A. Qualifications paragraphs in this article establish the minimum qualification levels required; individual Specification Sections specify additional requirements.

B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce the required units. As applicable, procure products from manufacturers able to meet qualification requirements, warranty requirements, and technical or factory-authorized service representative requirements.

C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Installer Qualifications: A firm or individual experienced in installing, erecting, applying, or assembling work similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful in-service performance.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of the system, assembly, or product that is similar in material, design, and extent to those indicated for this Project.

F. Specialists: Certain Specification Sections require that specific construction activities be performed by entities who are recognized experts in those operations. Specialists will satisfy qualification requirements indicated and engage in the activities indicated.

1. Requirements of authorities having jurisdiction supersede requirements for specialists.

G. Testing and Inspecting Agency Qualifications: A recognized accredited agency and/or the authority having jurisdiction; or an independent agency with the experience and capability to conduct testing and inspection indicated, as documented in accordance with ASTM E329, and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.

H. Manufacturer's Technical Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to observe and inspect installation of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

I. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect, demonstrate, repair, and perform service on installations of manufacturer's products that are similar in material, design, and extent to those indicated for this Project.

J. Preconstruction Testing: Where testing agency is indicated to perform preconstruction testing for compliance with specified requirements for performance and test methods, comply with the following:

1. Contractor’s Responsibilities

a. Provide test specimens representative of proposed products and construction.
b. Submit specimens in a timely manner with sufficient time for testing and analyzing results to prevent delaying the Work.
c. Provide sizes and configurations of test assemblies, mockups, and laboratory mockups to adequately demonstrate capability of products to comply with performance requirements.
d. Build site-assembled test assemblies and mockups, using installers who will perform same tasks for Project.
e. When testing is complete, remove test specimens and test assemblies, and mockups; do not reuse products on Project.

2. Testing Agency Responsibilities: Submit a certified written report of each test, inspection, and similar quality-assurance service to the Engineer and Commissioning Authority, with copy to Contractor. Interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from the Contract Documents.

K. Mockups: Before installing portions of the Work requiring mockups, build mockups for each form of construction and finish required to comply with the following requirements, using materials indicated for the completed Work:

1. Build mockups of size indicated.
2. Build mockups in location indicated or, if not indicated, as directed by the Engineer
3. Notify the Engineer seven (7) days in advance of dates and times when mockups will be constructed.

4. Employ supervisory personnel who will oversee mockup construction. Employ workers who will be employed to perform same tasks during the construction at Project.
5. Demonstrate the proposed range of aesthetic effects and workmanship.
6. Obtain Engineer's approval of mockups before starting corresponding Work, fabrication, or construction.

    a. Allow **seven (7)** days for initial review and each re-review of each mockup.

7. Promptly correct unsatisfactory conditions noted by the Engineer's preliminary review, to the satisfaction of the Engineer, before completion of final mockup.
8. Approval of mockups by the Engineer does not constitute approval of deviations from the Contract Documents contained in mockups unless the Engineer specifically approves such deviations in writing.
9. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
10. Demolish and remove mockups when directed unless otherwise indicated.

L. Specialty Mockups: See Section 014339 "Mockups" for additional construction requirements for mockups.

M. Integrated Exterior Mockups: Construct integrated exterior mockup in accordance with approved Shop Drawings Coordinate installation of exterior envelope materials and products for which mockups are required in individual specification sections, along with supporting materials.

N. Room Mockups: Construct room mockups incorporating required materials and assemblies, finished in accordance with requirements. Provide required lighting and additional lighting where required to enable the Engineer to evaluate the quality of the Work.

1.11 QUALITY CONTROL

A. Employer Responsibilities: Where quality-control services are indicated as Employer's responsibility, Employer will engage a qualified testing agency to perform these services.

1. Employer will furnish Contractor with names, addresses, and telephone numbers of testing agencies engaged and a description of types of testing and inspection they are engaged to perform. The Contractor shall engage such services at his own cost.
2. Where the Specifications states that the Employer shall or reserves the right to, engage the services of a qualified testing Agency to carry out tests, etc., such tests shall be undertaken by a third-party QA/QC bodies and / or testing agencies, as specified for quality control testing and/or third-party inspections, the services of which are to be engaged by the Contractor at his own costs
3. Costs for testing, retesting and reinspection construction that replaces or is necessitated by Work that failed to comply with the Contract Documents will be charged to the Contractor.

B. Contractor Responsibilities: Tests and inspections not explicitly assigned to Employer are Contractor's responsibility. Perform additional quality-control activities, whether specified or not, to verify and document that the Work complies with requirements.

1. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
2. Engage a qualified testing agency to perform quality-control services.

    a. Contractor will not employ same entity engaged by Employer, unless agreed to in writing by Employer.

3. Notify testing agencies at least twenty-four (24) hours in advance of time when Work that requires testing or inspection will be performed.

4. Where quality-control services are indicated as Contractor's responsibility, submit a certified written report, in duplicate, of each quality-control service.
5. Testing and inspection requested by the Contractor and not required by the Contract Documents are Contractor's responsibility.
6. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.

C. Retesting / Reinspection: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspection, for construction that replaced Work that failed to comply with the Contract Documents.

D. Testing Agency Responsibilities: Cooperate with the Engineer and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify the Engineer, Commissioning Authority and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
2. Determine the locations from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections, and state in each report whether tested and inspected Work complies with or deviates from requirements.
4. Submit a certified written report, in duplicate, of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase the Contract Document requirements or approve or accept any portion of the Work.
6. Do not perform duties of Contractor.

E. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing as specified in Section 013300 "Submittal Procedures."

F. Manufacturer's Technical Services: Where indicated, engage a manufacturer's technical representative to observe and inspect the Work. Manufacturer's technical representative's services include participation in preinstallation conferences, examination of substrates and conditions, verification of materials, observation of Installer activities, inspection of completed portions of the Work, and submittal of written reports.

G. Contractor's Associated Requirements and Services: Cooperate with agencies and representatives performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:

1. Access to the Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspection. Assist agency in obtaining samples.
4. Facilities for storage and field curing of test samples.
5. Delivery of samples to testing agencies.
6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
7. Security and protection for samples and for testing and inspection equipment at Project site.

H. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and quality-control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspection.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

I. Schedule of Tests and Inspections: Prepare a schedule of tests, inspections, and similar quality-control services required by the Contract Documents as a component of Contractor's quality-

control plan. Coordinate and submit concurrently with Contractor's Construction Schedule. Update and submit with each Application for Payment.

1. Schedule Contents: Include tests, inspections, and quality-control services, including Contractor- and Employer-retained services, commissioning activities, and other Project-required services paid for by other entities.
2. Distribution: Distribute schedule to the Employer, the Engineer, Commissioning Authority testing agencies, and each party involved in performance of portions of the Work where tests and inspections are required.

1.12 SPECIAL TESTS AND INSPECTIONS

A. Special Tests and Inspections: Employer will engage a qualified testing agency and/or special inspector to conduct special tests and inspections required by authorities having jurisdiction as the responsibility of Employer and as follows:

1. Verifying that manufacturer maintains detailed fabrication and quality-control procedures and reviewing the completeness and adequacy of those procedures to perform the Work.
2. Notifying the Engineer and Contractor promptly of irregularities and deficiencies observed in the Work during performance of its services.
3. Submitting a certified written report of each test, inspection, and similar quality-control service to the Engineer with copy to Contractor and to authorities having jurisdiction.
4. Submitting a final report of special tests and inspections at Substantial Completion, which includes a list of unresolved deficiencies.
5. Interpreting tests and inspections and stating in each report whether tested and inspected Work complies with or deviates from the Contract Documents.
6. Retesting and reinspection corrected Work.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 TEST AND INSPECTION LOG

A. Test and Inspection Log: Prepare a record of tests and inspections. Include the following:

1. Date test or inspection was conducted.
2. Description of the Work tested or inspected.
3. Date test or inspection results were transmitted to the Engineer.
4. Identification of testing agency or special inspector conducting test or inspection.

B. Maintain log at Project site. Post changes and revisions as they occur. Provide access to test and inspection log for the Engineer’s reference during normal working hours.

1. Submit log at Project Take Over as part of Project Record Documents.

3.2 REPAIR AND PROTECTION

A. General: On completion of testing, inspection, sample-taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Provide materials and comply with installation requirements specified in other Specification Sections or matching existing substrates and finishes. Restore patched areas

and extend restoration into adjoining areas with durable seams that are as invisible as possible. Comply with the Contract Document requirements for cutting and patching in Section 017300 "Execution."

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are the Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

3.3 CONTRACTOR'S QUALITY CONTROL ORGANIZATION

A. General: The Contractor is responsible for quality assurance and quality control of the Works, including portions of the Works performed by his subcontractors and suppliers.

B. Staff: The Contractor shall appoint Site staff led by a Project Quality Control Manager dedicated to quality control of the Works. The Quality Control Manager shall have prior experience in the same capacity or on similar projects of comparable type and size. Qualified quality control engineers shall be employed as required to assure quality in accordance with the Contract Documents. Quality control engineers shall report to the Project Quality Control Manager.

C. Staff Authority: The quality control staff shall have full authority within the Contractor's organization to take action necessary to ensure compliance with the Contract Documents. The quality control staff and organization shall be subject to approval by the Engineer.

D. Engineer's Monitoring: The Engineer shall perform continuous inspections on Site to verify that the Contractor is providing the necessary quality assurance and quality control. Procedures and forms for inspection requests and inspections shall be established as required by the Engineer. The Engineer shall be notified via Request for Inspection (RFI) forms of all quality inspections. The Engineer's attendance at inspections and signature on inspection forms shall not relieve the Contractor of his responsibility to provide quality control and quality assurance and to complete the Works in accordance with the Contract Documents.

END OF SECTION 014000

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SECTION 014200 - REFERENCES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions and other Division 01 Specifications sections, apply to this Section.

1.2 DEFINITIONS

A. General: Basic Contract definitions are included in the Conditions of the Contract.

B. "Approved": When used to convey Engineer's action on Contractor's submittals, applications, and requests, "approved" is limited to Engineer's duties and responsibilities as stated in the Conditions of the Contract.

C. "Directed": A command or instruction by Engineer. Other terms including "requested," "authorized," "selected," "required," and "permitted" have the same meaning as "directed."

D. "Indicated": Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."

E. "Regulations": Laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, and rules, conventions, and agreements within the construction industry that control performance of the Work.

F. "Furnish": Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

G. "Install": Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.

H. "Provide": Furnish and install, complete and ready for the intended use.

I. "Project Site": Space available for performing construction activities. The extent of Project site is shown on Drawings and may or may not be identical with the description of the land on which Project is to be built.

J. Taking Over: Substantial Completion

1.3 SPECIFICATION FORMAT AND CONTENT EXPLANATION

A. Specification Format: These Specifications are organized into Divisions and Sections based on the Construction Specifications Institute's latest version format and "Master Format" numbering system.

B. Specification Content: This division 1 of the Specification uses certain conventions for the style of language and the intended meaning of certain terms, words, and phrases when used in particular situations. These conventions are as follows:

1. Abbreviated Language: Language used is abbreviated. Words and meanings shall be interpreted as appropriate. Words implied, but not stated, shall be interpolated as the sense

requires. Singular words shall be interpreted as plural and plural words interpreted as singular where applicable as the context of the Contract Documents indicates.

2. Imperative mood and streamlined language are generally used. Requirements expressed in the imperative mood shall be performed by the Contractor. At certain locations in the Text, subjective language is used for clarity to describe responsibilities that shall be fulfilled indirectly by the Contractor or by others when so noted.

    a. The words "shall", "shall be", or "shall comply with", depending on the context, are implied where a colon (:) is used within a sentence or phrase.
    b. The word "per" means "in accordance with", "according to", "in compliance with", "complying with", and similar phrases.

1.4 INDUSTRY STANDARDS

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of the Contract Documents unless otherwise indicated.

    1. For standards referenced by applicable building codes, comply with dates of standards as listed in building codes.

C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents.

    1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

D. If requested by the Engineer, the Contractor shall submit the equivalent to any standard referred to in the Specifications and the Contractor shall convert the parameters mentioned in the specifications to be comparable with the equivalent standard

E. Conflicting Requirements: Where compliance with 2 or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different but apparently equal to the Engineer for a decision before proceeding.

    1. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of the requirements. Refer uncertainties to the Engineer for a decision before proceeding.

1.5 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities indicated in Gale's "Encyclopedia of Associations: National Organizations of the U.S." or in Columbia Books' "National Trade & Professional Associations of the United States."

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B. Industry Organizations, List: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities in the following list. The information in this list is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. AABC - Associated Air Balance Council; www.aabc.com.
2. AAMA - American Architectural Manufacturers Association; (see FGIA).
3. AAPFCO - Association of American Plant Food Control Officials; www.aapfco.org.
4. AASHTO - American Association of State Highway and Transportation Officials; www.transportation.org.
5. AATCC - American Association of Textile Chemists and Colorists; www.aatcc.org.
6. ABMA - American Bearing Manufacturers Association; www.americanbearings.org.
7. ABMA - American Boiler Manufacturers Association; www.abma.com.
8. ACI - American Concrete Institute;; www.concrete.org.
9. ACP - American Clean Power; (Formerly: American Wind Energy Association); www.cleanpower.org.
10. ACPA - American Concrete Pipe Association; www.concretepipe.org.
11. AEIC - Association of Edison Illuminating Companies, Inc. (The); www.aeic.org.
12. AF&PA - American Forest & Paper Association; www.afandpa.org.
13. AGA - American Gas Association; www.aga.org.
14. AHAM - Association of Home Appliance Manufacturers; www.aham.org.
15. AHRI - Air-Conditioning, Heating, and Refrigeration Institute (The); www.ahrinet.org.
16. AI - Asphalt Institute; www.asphaltinstitute.org.
17. AIA - American Institute of Architects (The); www.aia.org.
18. AISC - American Institute of Steel Construction; www.aisc.org.
19. AISI - American Iron and Steel Institute; www.steel.org.
20. AITC - American Institute of Timber Construction; (see PLIB).
21. AMCA - Air Movement and Control Association International, Inc.; www.amca.org.
22. AMPP - Association for Materials Protection and Performance; www.ampp.org.
23. ANSI - American National Standards Institute; www.ansi.org.
24. AOSA / SCST- Association of Official Seed Analysts, (The)/Society of Commercial Seed Technologists ; www. analyzeseeds.com.
25. APA - The Engineered Wood Association; www.apawood.org.
26. APA - Architectural Precast Association; www.archprecast.org.
27. API - American Petroleum Institute; www.api.org.
28. ARMA - Asphalt Roofing Manufacturers Association; www.asphaltroofing.org.
29. ASA - Acoustical Society of America; www.acousticalsociety.org.
30. ASCE - American Society of Civil Engineers; www.asce.org.
31. ASCE/SEI - American Society of Civil Engineers/Structural Engineering Institute; (See ASCE).
32. ASLA - American Society of Landscape Architects; www.asla.org.
33. ASHRAE - American Society of Heating, Refrigerating and Air-Conditioning Engineers; www.ashrae.org.
34. ASME - ASME International; (American Society of Mechanical Engineers); www.asme.org.
35. ASSE - ASSE International; American Society of Sanitary Engineering; www.asse-plumbing.org.
36. ASSP - American Society of Safety Professionals (The); www.assp.org.
37. ASTM - ASTM International; www.astm.org.
38. ATIS - Alliance for Telecommunications Industry Solutions; www.atis.org.
39. AVIXA - Audiovisual and Integrated Experience Association; www.avixa.org
40. AWI - Architectural Woodwork Institute; www.awinet.org.
41. AWMAC - Architectural Woodwork Manufacturers Association of Canada; www.awmac.com.
42. AWPA - American Wood Protection Association; www.awpa.com.
43. AWS - American Welding Society; www.aws.org.
44. AWWA - American Water Works Association; www.awwa.org.
45. BHMA - Builders Hardware Manufacturers Association; www.buildershardware.com.
46. BIA - Brick Industry Association (The); www.gobrick.com.
47. BICSI - BICSI, Inc. : www.bicsi.org.

48. BIFMA - Business and Institutional Furniture Manufacturer's Association); www.bifma.org.
49. BISSC - Baking Industry Sanitation Standards Committee; www.bissc.org.
50. BSI - British Standards Institution; www.bsigroup.com
51. BWF - Badminton World Federation; www. bwfbadminton.org.
52. CARB - California Air Resources Board; www.arb.ca.gov.
53. CDA - Copper Development Association; Inc.www.copper.org.
54. CE - Conformite Europeenne; (European Commission); www.ec.europa.eu/growth/single-market/ce-marking.
55. CEA - Canadian Electricity Association; www.electricity.ca.
56. CFFA - Chemical Fabrics and Film Association, Inc.; www.chemicalfabricsandfilm.com.
57. CFSEI - Cold-Formed Steel Engineers Institute; www.cfsei.org.
58. CGA - Compressed Gas Association; www.cganet.com.
59. CIMA - Cellulose Insulation Manufacturers Association; www.cellulose.org.
60. CISCA - Ceilings & Interior Systems Construction Association; www.cisca.org.
61. CISPI - Cast Iron Soil Pipe Institute; www.cispi.org.
62. CLFMI - Chain Link Fence Manufacturers Institute; www.chainlinkinfo.org.
63. CMHA - Concrete Masonry & Hardscape Association; (Formerly: National Concrete Masonry Association); www.masonryandhardscapes.org.
64. CPA - Composite Panel Association; www.compositepanel.org.
65. CRI - Carpet and Rug Institute (The); www.carpet-rug.org.
66. CRRC - Cool Roof Rating Council; www.coolroofs.org.
67. CRSI - Concrete Reinforcing Steel Institute; www.crsi.org.
68. CSA - CSA Group; www.csa-group.org.
69. CSI - Cast Stone Institute; www.caststone.org.
70. CSI - Construction Specifications Institute (The); www.csiresources.org.
71. CSSB - Cedar Shake & Shingle Bureau; www.cedarbureau.org.
72. CTA - Consumer Technology Association; www.cta.tech.
73. CTI - Cooling Technology Institute; ; www.coolingtechnology.org.
74. DASMA - Door and Access Systems Manufacturers Association; www.dasma.com.
75. DHA - Decorative Hardwoods Association; www.decorativehardwoods.org.
76. DHI - Door and Hardware Institute; www.dhi.org.
77. ECIA - Electronic Components Industry Association; www.ecianow.org.
78. EIMA - EIFS Industry Members Association; www.eima.com.
79. EJMA - Expansion Joint Manufacturers Association, Inc.; www.ejma.org.
80. EOS/ESD Association; Inc.; Electrostatic Discharge Association; www.esda.org.
81. ESTA - Entertainment Services and Technology Association. www.esta.org.
82. EVO - Efficiency Valuation Organization; www.evo-world.org.
83. FCI - Fluid Controls Institute; www.fluidcontrolsinstitute.org.
84. FGIA - Fenestration and Glazing Industry Alliance; https://fgiaonline.org.
85. FIBA - Federation Internationale de Basketball; (The International Basketball Federation); www.fiba.com.
86. FIVB - Federation Internationale de Volleyball; (The International Volleyball Federation); www.fivb.org.
87. FM Approvals - FM Approvals LLC; www.fmapprovals.com.
88. FM Global - FM Global; www.fmglobal.com.
89. FRSA - Florida Roofing and Sheet Metal Contractors Association, Inc.; www.floridaroof.com.
90. FSA - Fluid Sealing Association; www.fluidsealing.com.
91. FSC - Forest Stewardship Council U.S.; www.fscus.org.
92. GA - Gypsum Association; www.gypsum.org.
93. GS - Green Seal; www.greenseal.org.
94. HI - Hydraulic Institute; www.pumps.org.
95. HMMA - Hollow Metal Manufacturers Association; (See NAAMM).
96. IAPSC - International Association of Professional Security Consultants; www.iapsc.org.
97. IAS - International Accreditation Service; www.iasonline.org.
98. ICC - International Code Council; www.iccsafe.org.
99. ICEA - Insulated Cable Engineers Association, Inc.; www.icea.net.
100. ICPA - International Cast Polymer Association; www.theicpa.com.
101. ICRI - International Concrete Repair Institute, Inc.; www.icri.org.

102. IEC - International Electrotechnical Commission; www.iec.ch.
103. IEEE - SA - IEEE Standards Association; https://standards.www.ieee.org
104. IES - Illuminating Engineering Society; www.ies.org.
105. IEST - Institute of Environmental Sciences and Technology; www.iest.org.
106. IGMA - Insulating Glass Manufacturers Alliance; www.igmaonline.org.
107. IGSHPA - International Ground Source Heat Pump Association; www.igshpa.org.
108. ILI - Indiana Limestone Institute of America, Inc.; www.iliai.com.
109. Intertek - Intertek Group; (Formerly: ETL SEMCO; Intertek Testing Service NA); www.intertek.com.
110. ISA - International Society of Arboriculture; www.isa-arbor.com.
111. ISA - International Society of Automation (The); www.isa.org.
112. ISFA - International Surface Fabricators Association; (Formerly: International Solid Surface Fabricators Association); www.isfanow.org.
113. ISO - International Organization for Standardization; www.iso.org.
114. ITU - International Telecommunication Union; www.itu.int.
115. KCMA - Kitchen Cabinet Manufacturers Association; www.kcma.org.
116. LPI - Lightning Protection Institute; www.lightning.org.
117. MBMA - Metal Building Manufacturers Association; www.mbma.com.
118. MCA - Metal Construction Association; www.metalconstruction.org.
119. MFMA - Maple Flooring Manufacturers Association, Inc.; www.maplefloor.org.
120. MFMA - Metal Framing Manufacturers Association, Inc.; www.metalframingmfg.org.
121. MHI - Material Handling Industry; www.mhi.org.
122. MMPA - Moulding & Millwork Producers Association; www.wmmpa.com.
123. MPI - Master Painters Institute; www.paintinfo.com.
124. MSS - Manufacturers Standardization Society of The Valve and Fittings Industry Inc.; www.msshq.org.
125. NAAMM - National Association of Architectural Metal Manufacturers; www.naamm.org.
126. NACE - NACE International; (National Association of Corrosion Engineers International); (see AMPP).
127. NADCA - National Air Duct Cleaners Association; www.nadca.com.
128. NAIMA - North American Insulation Manufacturers Association; www.insulationinstitute.org.
129. NALP - National Association of Landscape Professionals; www.landscapeprofessionals.org.
130. NBGQA - National Building Granite Quarries Association, Inc.; www.nbgqa.com.
131. NBI - New Buildings Institute; www.newbuildings.org.
132. NCAA - National Collegiate Athletic Association (The); www.ncaa.org.
133. NCMA - National Concrete Masonry Association; (see CMHA).
134. NEBB - National Environmental Balancing Bureau; www.nebb.org.
135. NECA - National Electrical Contractors Association; www.necanet.org.
136. NeLMA - Northeastern Lumber Manufacturers Association; www.nelma.org.
137. NEMA - National Electrical Manufacturers Association; www.nema.org.
138. NETA - InterNational Electrical Testing Association; www.netaworld.org.
139. NFHS - National Federation of State High School Associations; www.nfhs.org.
140. NFPA - National Fire Protection Association; www.nfpa.org.
141. NFPA - NFPA International; (see NFPA).
142. NFRC - National Fenestration Rating Council; www.nfrc.org.
143. NGA - National Glass Association; www.glass.org.
144. NHLA - National Hardwood Lumber Association; www.nhla.com.
145. NLGA - National Lumber Grades Authority; www.nlga.org.
146. NOFMA - National Oak Flooring Manufacturers Association; (see NWFA).
147. NOMMA - National Ornamental & Miscellaneous Metals Association; www.nomma.org.
148. NRCA - National Roofing Contractors Association; www.nrca.net.
149. NRMCA - National Ready Mixed Concrete Association; www.nrmca.org.
150. NSF - NSF International; www.nsf.org.
151. NSI - Natural Stone Institute; www.naturalstoneinstitute.org.
152. NSPE - National Society of Professional Engineers; www.nspe.org.
153. NSSGA - National Stone, Sand & Gravel Association; www.nssga.org.
154. NTMA - National Terrazzo & Mosaic Association, Inc. (The); www.ntma.com.
155. NWFA - National Wood Flooring Association; www.nwfa.org.

156. NWRA - National Waste & Recycling Association; www.wasterecycling.org
157. PCI - Precast/Prestressed Concrete Institute; www.pci.org.
158. PDI - Plumbing & Drainage Institute; www.pdionline.org.
159. PLASA - PLASA; www.plasa.org.
160. PLIB - Pacific Lumber Inspection Bureau; www.plib.org.
161. PVCPA - Uni-Bell PVC Pipe Association; www.uni-bell.org.
162. RCSC - Research Council on Structural Connections; www.boltcouncil.org.
163. RFCI - Resilient Floor Covering Institute; www.rfci.com.
164. RIS - Redwood Inspection Service;.(see WWPA)
165. SAE - SAE International; www.sae.org.
166. SCTE - Society of Cable Telecommunications Engineers; www.scte.org.
167. SDI - Steel Deck Institute; www.sdi.org.
168. SDI - Steel Door Institute; www.steeldoor.org.
169. SEFA - Scientific Equipment and Furniture Association (The); www.sefalabs.com.
170. SEI/ASCE - Structural Engineering Institute/American Society of Civil Engineers; (see ASCE).
171. SIA - Security Industry Association; www.securityindustry.org.
172. SJI - Steel Joist Institute; www.steeljoist.org.
173. SMA - Screen Manufacturers Association; www.smainfo.org.
174. SMACNA - Sheet Metal and Air Conditioning Contractors' National Association; www.smacna.org.
175. SMPTE - Society of Motion Picture and Television Engineers; www.smpte.org.
176. SPFA - Spray Polyurethane Foam Alliance; www.sprayfoam.org.
177. SPIB - Southern Pine Inspection Bureau; www.spib.org.
178. SPRI - Single Ply Roofing Industry; www.spri.org.
179. SRCC - Solar Rating & Certification Corporation; www.solar-rating.org.
180. SSINA - Specialty Steel Industry of North America; www.ssina.com.
181. SSPC - SSPC: The Society for Protective Coatings; (see AMPP).
182. STI / SPFA- Steel Tank Institute/ Steel Plate Fabricators Association; www.steeltank.com.
183. SWI - Steel Window Institute; www.steelwindows.com.
184. SWPA - Submersible Wastewater Pump Association; www.swpa.org.
185. TCA - Tilt-Up Concrete Association; www.tilt-up.org.
186. TCNA - Tile Council of North America, Inc.; www.tcnatile.com.
187. TEMA - Tubular Exchanger Manufacturers Association, Inc.; www. kbcdco.tema.org.
188. TIA - Telecommunications Industry Association; www.tiaonline.org.
189. TMS - The Masonry Society; www.masonrysociety.org.
190. TPI - Truss Plate Institute; www.tpinst.org.
191. TPI - Turfgrass Producers International; www.turfgrasssod.org.
192. TRI - Tile Roofing Industry Alliance; www.tileroofing.org.
193. ULSE - UL - Standards & Engagement Inc.; www.ulse.org.
194. UL - UL Solutions Inc.; www.ul.com.
195. USAV - USA Volleyball; www.usavolleyball.org.
196. USGBC - U.S. Green Building Council; www.usgbc.org.
197. USITT - United States Institute for Theatre Technology, Inc.; www.usitt.org.
198. WA - Wallcoverings Association; www.wallcoverings.org.
199. WCLIB - West Coast Lumber Inspection Bureau; (see PLIB)
200. WCMA - Window Covering Manufacturers Association; www.wcmanet.org.
201. WDMA - Window & Door Manufacturers Association; www.wdma.com.
202. WI - Woodwork Institute; www.woodworkinstitute.com.
203. WSRCA - Western States Roofing Contractors Association; www.wsrca.com.
204. WWPA - Western Wood Products Association; http://www.wwpa.org.

C. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities in the following list. This information is believed to be accurate as of the date of the Contract Documents.

1. DIN - Deutsches Institut fur Normung e.V.; www.din.de.
2. IAPMO - International Association of Plumbing and Mechanical Officials; www.iapmo.org.
3. ICC - International Code Council; www.iccsafe.org.

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4. ICC-ES - ICC Evaluation Service, LLC; www.icc-es.org.

D. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities in the following list. Information is subject to change and is up to date as of the date of the Contract Documents.

1. ADA - Americans with Disabilities Act; www.ada.gov.
2. CPSC - U.S. Consumer Product Safety Commission; www.cpsc.gov.
3. DOC - U.S. Department of Commerce; www.commerce.gov.
4. DOD - U.S. Department of Defense; defense.gov.
5. DOE - U.S. Department of Energy; www.energy.gov.
6. DOJ - U.S. Department of Justice; www.ojp.usdoj.gov
7. DOS - U.S. Department of State; www.state.gov.
8. EPA - United States Environmental Protection Agency; www.epa.gov.
9. FAA - Federal Aviation Administration; www.faa.gov.
10. GPO - U.S - Government Publishing Office; www.gpo.gov.
11. GSA – U.S. General Services Administration; www.gsa.gov.
12. HUD – U.S. Department of Housing and Urban Development; www.hud.gov.
13. LBNL - Lawrence Berkeley National Laboratory; Energy Technologies Area; www.lbl.gov.
14. NIST - National Institute of Standards and Technology; www.nist.gov.
15. OSHA - Occupational Safety & Health Administration; www.osha.gov.
16. TRB - Transportation Research Board; National Cooperative Highway Research Program; The National Academies; www.trb.org.
17. USACE - U.S. Army Corps of Engineers; www.usace.army.mil.
18. USDA – U.S. Department of Agriculture; Agriculture Research Service; U.S. Salinity Laboratory; www.ars.usda.gov.
19. USDA – U.S. Department of Agriculture; Rural Utilities Service; www.usda.gov.
20. USP - U.S. Pharmacopeial Convention; www.usp.org.
21. USPS - United States Postal Service; www.usps.com.

E. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the standards and regulations in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

1. CFR - Code of Federal Regulations; Available from Government Publishing Office; www.govinfo.gov.
2. DOD – U.S. Department of Defense; Military Specifications and Standards; Available from DLA Document Services; www.dsp.dla.mil/Specs-Standards/.
3. DSCC - Defense Supply Center Columbus; (see FS).
4. FED-STD - Federal Standard; (see FS).
5. FS - Federal Specification; Available from DLA Document Services; www.dsp.dla.mil/Specs-Standards/.

    a. Available from Defense Standardization Program; www.dsp.dla.mil.
    b. Available from U.S. General Services Administration; www.gsa.gov.
    c. Available from National Institute of Building Sciences/Whole Building Design Guide; www.wbdg.org.

6. MILSPEC - Military Specifications and Standards; (see DOD).
7. USAB - United States Access Board; www.access-board.gov.
8. USATBCB - U.S. Architectural & Transportation Barriers Compliance Board; (see USAB).

F. State Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they are to mean the recognized name of the entities in the following list. This information is subject to change and is believed to be accurate as of the date of the Contract Documents.

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1. BEARHFTI California; Bureau of Electronic and Appliance Repair, Home Furnishings and Thermal Insulation; (see BHGS)
2. BHGS; State of California Bureau of Household Goods and Services; (Formerly: California Bureau of Electronic and Appliance Repair, Home Furnishings and Thermal Insulation); www.bhgs.dca.ca.gov.
3. CCR; California Code of Regulations; Office of Administrative Law; California Title 24 Energy Code; www.oal.ca.gov/publications/ccr/.
4. CDPH; California Department of Public Health; Indoor Air Quality Program;www.cdph.ca.gov/Programs/CCDPHP/DEODC/EHLB/IAQ/Pages/Main-Page.aspx.
5. CPUC; California Public Utilities Commission; www.cpuc.ca.gov.
6. SCAQMD; South Coast Air Quality Management District; www.aqmd.gov.
7. TFS; Texas A&M Forest Service; Sustainable Forestry and Economic Development; https:///tfsweb.tamu.edu/.

1.6 CONTRACTOR'S REPONSIBILITY

A. All information provided in this Section is furnished for information only and is not a warranty of accuracy or completeness. The Contractor shall review and verify all such information and shall notify the Engineer, in writing, of any corrections, discrepancies, or required updates. Provide such notice within 28 days after the Commencement Date, or within 28 days after the Contractor becomes aware (or should have become aware) of such update, whichever occurs later.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 014200

SECTION 014339 - MOCKUPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Integrated exterior mockups (if required and as indicated on drawings).
2. Preconstruction laboratory mockups. (if required and as indicated on drawings).
3. Room mockups. (if required and as indicated on drawings).

1.3 DEFINITIONS

A. Integrated Exterior Mockups: Mockups of the exterior envelope constructed on-site as freestanding temporary built elements and part of permanent construction, consisting of multiple products, assemblies, and subassemblies.

B. Preconstruction Laboratory Mockups: Integrated exterior mockups constructed at testing facility to verify performance characteristics.

C. Room Mockups: Mockups of typical interior spaces complete with wall, floor, and ceiling finishes; doors; windows; millwork; casework; specialties; furnishings and equipment; and lighting as indicated.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1. Meet with Employer, Engineer, testing and inspecting agency representative, and installers of major systems whose Work is included in integrated exterior, preconstruction laboratory and room mockups.
2. Review coordination of equipment and furnishings provided by the Employer for room mockups.
3. Review locations and extent of mockups.
4. Review testing procedures to be performed on mockups.
5. Review and finalize schedule for mockups, and verify availability of materials, personnel, equipment, and facilities needed to complete mockups and testing and maintain schedule for the Work.

1.5 ACTION SUBMITTALS

A. Shop Drawings: For integrated exterior, preconstruction laboratory and room mockups.

1. Include plans, elevations, sections, and mounting and support details.

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2. Indicate manufacturer and model number of individual components, subassemblies, and assemblies.
3. Include site location drawing indicating orientation of mockup.
4. Revise and resubmit Shop Drawings to reflect approved modifications in details and component interfaces resulting from changes made during testing procedures.

B. Delegated Design Submittal: For temporary structural supports for mockups not attached to building structure, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

A. Room Mockup Coordination Drawings: and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

B. Qualification Data: For testing agency.

C. Preconstruction Test Reports: For integrated exterior and preconstruction laboratory mockups.

1.7 QUALITY ASSURANCE

A. Preconstruction Laboratory Mockup Testing Agency Qualifications: Qualif Accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025.

B. Testing Agency Qualifications: Accredited by IAS or ILAC Mutual Recognition Arrangement as complying with ISO/IEC 17025 and acceptable to Employer and Engineer.

C. Build mockups to do the following:

1. Verify selections made under Sample submittals.
2. Demonstrate aesthetic effects.
3. Demonstrate the qualities of products and workmanship.
4. Demonstrate acceptable coordination between components and systems.
5. Perform preconstruction testing, such as window air- and water-leakage testing.

D. Fabrication: Before fabricating or installing portions of the Work requiring mockups, build mockups for each form of construction and finish required. Use materials and installation methods as required for the Work.

1. Build mockups of size indicated.
2. Build mockups in location indicated or, if not indicated, as directed by Engineer.
3. Employ supervisory personnel who will oversee mockup construction. Employ workers who will be employed to perform same tasks during the construction at Project.
4. Demonstrate the proposed range of aesthetic effects and workmanship.
5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
6. Demolish and remove mockups when directed unless otherwise indicated.

E. Notifications:

1. Notify Engineer seven days in advance of the dates and times when mockups will be constructed.
2. Notify Engineer 14 days in advance of the dates and times when mockups will be tested.
3. Allow seven days for initial review and each re-review of each mockup.

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F. Approval: Obtain Engineer's approval of mockups before starting fabrication or construction of corresponding Work.

1. Unless otherwise indicated, approved mockups establish the standard by which the Work will be judged.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Engineer specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 COORDINATION

A. Coordinate schedule for construction of mockups, so construction, testing, and review of mockups do not impact Project schedule.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Structural Performance:

1. Seismic Performance: Mockups and support structure to withstand the effects of earthquake motions determined in accordance with ASCE/SEI 7 and as indicated in structural report
2. Wind Loads: As indicated in structural report.

B. Mockup Testing Performance Requirements: Perform tests using design pressures and performance criteria indicated for assemblies and products that are specified in other Sections and incorporated into integrated exterior and preconstruction laboratory mockups.

2.2 INTEGRATED EXTERIOR MOCKUPS (if required and as indicated on drawings).

A. Construct integrated exterior mockups according to approved mockup Shop Drawings and in accordance with the mockups specified in the Contract documents. Construct mockups to demonstrate constructability, coordination of trades, and sequencing of Work; and to ensure materials, components, subassemblies, assemblies, and interfaces integrate into a system complying with indicated performance and aesthetic requirements.

B. Design and construct foundation and superstructure to support free-standing integrated exterior mockups.

C. Build integrated exterior mockups using installers and construction methods that will be used in completed construction.

D. Use specified products that have been approved by Engineer. Coordinate installation of materials and products specified in individual Specification Sections that include Work included in integrated exterior mockups.

E. The Work of integrated exterior mockups includes, but is not limited to, the following:

1. Precast architectural concrete.
2. Stone cladding.
3. Cold-formed metal framing and sheathing.
4. Air and weather barriers.

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5. Thermal insulation.
6. Through-wall flashing.
7. Flashing and sheet metal trim.
8. Joint sealants.
9. Metal wall panels.
10. Aluminum-framed entrances and storefront.
11. Glazed curtain walls.
12. Aluminum windows.
13. Glazing.

F. Photographic Documentation: Document construction of integrated exterior mockups with photographs. Provide photographs showing details of interface of different materials and assemblies.

1. Document testing procedures, including water leakage and other deficiencies. Photograph modifications to component interfaces intended to correct deficiencies.

G. Provide and document modifications to construction details and interfaces between components and systems required to properly sequence the Work, or to pass performance testing requirements. Obtain Engineer's approval for modifications.

H. Retain approved mockups constructed in place. Incorporate fully into the Work.

2.3 PRECONSTRUCTION LABORATORY MOCKUPS (if required and as indicated on drawings)

A. Construct preconstruction laboratory mockups according to approved Shop Drawings in accordance with the mockups specified in the Contract documents. Construct mockups to demonstrate constructability, coordination of trades, and sequencing of Work; ensure materials, components, subassemblies, assemblies, and interfaces integrate into a system complying with indicated performance and aesthetic requirements; and conduct performance testing indicated.

B. Build preconstruction laboratory mockups at testing agency facility using installers and construction methods that will be used at Project site.

C. Use specified products that have been approved by Engineer. Coordinate installation of materials and products specified in individual Specification Sections that include Work included in preconstruction laboratory mockups.

D. The Work of preconstruction laboratory mockups includes, but is not limited to, the following:

1. Precast architectural concrete.
2. Stone cladding.
3. Cold-formed metal framing and sheathing.
4. Air and weather barriers.
5. Thermal insulation.
6. Through-wall flashing.
7. Flashing and sheet metal trim.
8. Joint sealants.
9. Metal wall panels.
10. Standing seam.
11. Skylight.
12. Aluminum-framed entrances and storefront.
13. Glazed curtain walls.
14. Aluminum windows.
15. Glazing.

E. Photographic Documentation: Document construction of preconstruction laboratory mockups with photographs. Provide photographs showing details of interface of different materials and assemblies.

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1. Document testing procedures, including water leakage and other deficiencies. Photograph modifications to component interfaces intended to correct deficiencies.

F. Provide and document modifications to construction details and interfaces between components and systems required to properly sequence the Work, or to pass performance testing requirements. Obtain Engineer's approval for modifications.

G. When testing is complete, remove test specimens and test assemblies, and preconstruction laboratory mockups; do not reuse products on Project.

2.4 ROOM MOCKUPS (if required and as indicated on drawings)

A. Build room mockups according to approved mockup Shop Drawings to evaluate constructability, demonstrate the coordination of trades and sequencing of Work, and to demonstrate aesthetic requirements. Include each visible finish, component, and equipment item within room mockups; include operable lighting.

B. Provide room mockups in accordance with the mockups specified in the Contract documents.

C. The Work of room mockups includes, but is not limited to, the following:

1. Millwork and casework.
2. Doors and frames.
3. Access doors and frames.
4. Glazing.
5. Metal framing.
6. Gypsum board.
7. Ceramic tiling.
8. Acoustical ceilings.
9. Resilient flooring.
10. Painting.
11. Registers and grilles.
12. Wiring devices.
13. Lighting.

PART 3 - EXECUTION

3.1 TESTING OF INTEGRATED EXTERIOR MOCKUPS

A. Integrated Exterior Mockup Testing Agency: Engage a qualified testing agency to perform tests and inspections.

1. Testing and inspecting agency will interpret tests and state in each report whether tested Work complies with or deviates from requirements.

B. Integrated Exterior Mockup Testing Services: Perform the following tests in the following order:

1. Water-Spray Test: Before installation of interior finishes has begun, test areas designated by Engineer in accordance with AAMA 501.2 for evidence of water penetration.

a. Perform a minimum of three tests in areas as directed by Engineer.

2. Air Leakage: Test in accordance with ASTM E783 at 1.5 times the rate specified in "Mockup Testing Performance Requirements" Paragraph in "Performance Requirements" Article, but not more than 0.45 L/s per sq. m at a static-air-pressure differential of 75 Pa.

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a. Perform a minimum of three tests in areas as directed by Engineer.

3. Water Penetration: Test in accordance with ASTM E1105 at a minimum uniform and cyclic static-air-pressure differential of 0.67 times the static-air-pressure differential specified for laboratory testing in "Mockup Testing Performance Requirements" Paragraph in "Performance Requirements" Article, but not less than 300 Pa, and verify no evidence of water penetration.

C. .

D. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and installations, including connections, and also to observe testing for the following systems and assemblies.

1. Curtain wall specified in:
   a. Section Curtain Walls."
   b. Section Metal wall panels.
   c. Standing seam.
   d. Skylight.
   e. Glazing assemblies related section.

E. Integrated exterior mockup will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

3.2 TESTING OF PRECONSTRUCTION LABORATORY MOCKUPS

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

1. Testing and inspecting agency will interpret tests and state in each report whether tested Work complies with or deviates from requirements.

B. Testing Criteria: Where the following tests are indicated, use criteria indicated.

1. Air Leakage in Accordance with ASTM E283: Static-air-pressure differential of 600 Pa.
2. Water Penetration in Accordance with ASTM E331: Minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 720 Pa.

C. Unlock, open, and relock operable windows and doors five times. Perform necessary hardware adjustments, if any, and repeat cycling.

D. Preconstruction Laboratory Mockup Testing: Perform the following tests in the following order.

1. Structural, 50 Percent: ASTM E330/E330M at 50 percent of positive test load for not less than 10 seconds.
2. Air Leakage: ASTM E283.
3. Water Penetration under Static Pressure: ASTM E331.
4. Water Penetration under Dynamic Pressure: AAMA 501.1 at minimum air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 720 Pa.
5. Interstory Drift: AAMA 501.4 at 100 percent of design displacement. Repeat the following:

   a. Air Leakage: ASTM E283.
   b. Water Penetration under Static Pressure: ASTM E331.

6. Vertical Interstory Movement: AAMA 501.7 at 100 percent of design displacement. Repeat the following:

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a. Air Leakage: ASTM E283.
b. Water Penetration under Static Pressure: ASTM E331.

7. Thermal Cycling: AAMA 501.5. Repeat the following:

a. Air Leakage: ASTM E283.
b. Water Penetration under Static Pressure: ASTM E331.

8. Structural, 100 Percent: ASTM E330/E330M at 100 percent of positive and negative test loads for not less than 10 seconds. Repeat the following:

a. Air Leakage: ASTM E283.
b. Water Penetration under Static Pressure: ASTM E331.
c. Water Penetration under Dynamic Pressure: AAMA 501.1.

9. Structural, 150 Percent: ASTM E330/E330M at 150 percent of positive and negative test loads for not less than 10 seconds.
10. Interstory Drift: AAMA 501.4 at 150 percent of design displacement.

E. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and installations, including connections, and also to observe testing for the following systems and assemblies.

1. Curtain wall specified in Section:

a. Glazed Aluminum Curtain Wall.
b. Aluminum windows
c. Glazing assemblies related section.

F. Preconstruction laboratory mockup will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

3.3 MAINTENANCE

A. Maintain mockups during course of construction or until removal is directed.

B. Repair damage to mockups immediately upon occurrence. Maintain mockups and surrounding site in a safe and clean condition.

3.4 REMOVAL

A. Remove mockups at the completion of the work in a manner that shows no evidence of mock up's previous existence. Complete site work at area of mock up in accordance with Contract Drawings.

END OF SECTION 014339

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SECTION 015000 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions and other Division 01 Specifications sections, apply to this Section.

1.2 SUMMARY

A. Section includes requirements for temporary utilities, support facilities, and security and protection facilities.

B. Related Requirements

1. Division 01 Section 011000 "Summary" for work restrictions and limitations on utility interruptions.
2. Division 01 Section 011200 "Multiple Contract Summary" for responsibilities for temporary facilities and controls for projects utilizing multiple contracts.
3. Division 32 section 321313 "Concrete Paving" for construction and maintenance of cement concrete pavement for temporary roads and paved areas.

1.3 USE CHARGES

A. Installation, removal, and use charges for temporary facilities shall be included in the Contract Price unless otherwise indicated. Allow other entities engaged in the Project to use temporary services and facilities without cost, including, but not limited to the Employer's construction forces, Engineer, occupants of Project, testing agencies, and authorities having jurisdiction.

B. Sewer Service: Pay sewer-service use charges for sewer usage by all entities for construction operations. Arrange and pay for all temporary connections (installation, removal and reinstatement) and all associated administrative costs for permits, NOC’s etc. as necessary.

C. Water Service: Pay water-service use charges for water used by all entities for construction operations. Arrange and pay for all temporary connections (installation, removal and reinstatement) and all associated administrative costs for permits, NOC’s etc. as necessary.

D. Electric Power Service: Pay electric-power-service use charges for electricity used by all entities for construction operations. Arrange and pay for all temporary connections (installation, removal and reinstatement) and all associated administrative costs for permits, NOC’s etc. as necessary.

E. Telecom Services:

1. Pay for all connections, reconnections, service and user charges and other costs arising in connection with the continuation of all telecom facilities and services (Telephone and Internet) for the Engineer / Employer, other than the cost of international telephone calls not connected with the Works.
2. Obtain any permits / NOCS and provide all connections and extensions of services as necessary and metering at the Contractor’s own expense, to monitor the telecom service and maintain monthly records.
3. Remove all temporary connections and extensions and reinstate as before, as part of the Contractor’s demobilization from Site.

F. Water and Sewer Service from Existing System: Water from Employer's existing water system is available for use with metering**.** Provide connections and extensions of services and metering as required for construction operations, starting from the contract Commencement Date to the end of the Defects Liability Period. However, in case of metering, the following will be adopted:

1. If the Contract is delayed without an award of an Extension of Time or penalty waiver, the Contractor shall pay for the water consumption and sewer service for the temporary site facilities and any temporary or permanent works during the delayed period.
2. If any outstanding works and / or rectification of any defect works are not completed on time during the Defects Liability Period, the Contractor shall pay for the water consumption and sewer service for the temporary site facilities and completing any outstanding works and / or rectification of any defect works during the extended period.
3. Obtain any permits / NOCS and provide all connections and extensions of services as necessary and metering at the Contractor’s own expense, to monitor the water consumption and sewer service and maintain monthly records.
4. Use water services on Site in a conservative way, and strictly for construction purposes only for the Contract and no other locations.
5. Remove all temporary connections and extensions and reinstate as before, as part of the Contractor’s demobilization from Site.

G. Electric Power Service from Existing System: Electric power from Employer's existing system is available for use with metering. Provide connections and extensions of services and metering as required for construction operations, starting from the contract Commencement Date to the end of the Defects Liability Period. However, in case of metering, the following will be adopted:

1. If the Contract is delayed without an award of an Extension of Time or penalty waiver, the Contractor shall pay for the electric power consumption for the temporary site facilities and any temporary or permanent works during the delayed period.
2. If any outstanding works and / or rectification of any defect works are not completed on time during the Defects Liability Period, the Contractor shall pay for the electric power consumption for the temporary site facilities and completing any outstanding works and / or rectification of any defect works during the extended period.
3. Obtain any permits / NOCS and provide all connections and extensions of services as necessary and metering at the Contractor’s own expense, to monitor the electric power consumption and maintain monthly records.
4. Use electric power services on Site in a conservative way, and strictly for construction purposes only for the Contract and no other locations.
5. Remove all temporary connections and extensions and reinstate as before, as part of the Contractor’s demobilizations from Site.

H. Sewer, Water, and Electric Power Service: Use charges are specified in Section 011200 "Multiple Contract Summary."

I. Telephone Service: Pay telephone service use charges, for telephones installed at Site.

1.4 INFORMATIONAL SUBMITTALS

A. Site Utilization Plan: Show temporary facilities, temporary utility lines and connections, staging areas, construction site entrances, staging areas, vehicle circulation, and parking areas for construction personnel. Seek approval or changes as desired by the Employer.

B. Implementation and Termination Schedule: Within fifteen (15) days of date established for commencement of the Work, submit schedule indicating implementation and termination dates of each temporary utility.

C. Project Identification and Temporary Signs: Show fabrication and installation details, including plans, elevations, details, layouts, typestyles, graphic elements, and message content.

D. Erosion and Sedimentation Control Plan: Show compliance with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent.

E. Fire-Safety Program: Show compliance with requirements of Fire and Life Safety Code of Practice, NFPA 241 and authorities having jurisdiction. Indicate Contractor personnel responsible for management of fire-prevention program.

F. Moisture- and Mold-Protection Plan: Describe procedures and controls for protecting materials and construction from water absorption and damage and mold. Describe delivery, handling, storage, installation, and protection provisions for materials subject to water absorption or water damage.

1. Indicate procedures for discarding water-damaged materials, protocols for mitigating water intrusion into completed Work, and requirements for replacing water-damaged Work.
2. Indicate sequencing of work that requires water, such as sprayed fire-resistive materials, plastering, and terrazzo grinding, and describe plans for dealing with water from these operations. Show procedures for verifying that wet construction has dried sufficiently to permit installation of finish materials.
3. Indicate methods to be used to avoid trapping water in finished work.

G. Dust and HVAC Control Plan: Submit coordination drawing and narrative that indicates the dust- and HVAC-control measures proposed for use, proposed locations, and proposed time frame for their operation. Include the following:

1. Locations of dust control partitions at each phase of work.
2. HVAC system isolation schematic drawing.
3. Location of proposed air-filtration system discharge.
4. Waste-handling procedures.
5. Other dust-control measures.

H. Noise and Vibration Control Plan: Identify construction activities that may impact the occupancy and use of existing spaces within the building or adjacent existing buildings, whether occupied by others, or occupied by the Employer. Include the following:

1. Methods used to meet the goals and requirements of the Employer.
2. Concrete cutting method(s) to be used.
3. Location of construction plant and machinery on the site.
4. Show compliance with the use and maintenance of quieted construction plant and machinery for the duration of the Project.
5. Indicate activities that may disturb building occupants and that are planned to be performed during non-standard working hours as coordinated with the Employer.
6. Indicate locations of sensitive research, patient, and equipment areas or other areas requiring special attention as identified by Employer. Indicate means for complying with Employer's requirements.

I. Temporary Utility Reports: Submit reports of tests, inspections, maintenance, meter readings, and similar procedures performed on temporary utilities.

J. Insert requirements for submitting installation Drawings of critical temporary utilities if required.

K. Temporary Utilities: Submit detailed proposals including drawings and product data as requested; obtain the Engineer’s approval prior to purchase, delivery, installation or implementation, as applicable, of the following:

1. Sewers and drainage.
2. Water service and distribution.
3. Sanitary facilities, including toilets, wash facilities, and drinking-water facilities.
4. Electric power service.
5. Telecom service.

L. Support Facilities: Submit detailed proposals including drawings and product data as requested for the layout area for the location of the support facilities not later than two weeks of issuance of the Notice to Commence; obtain the Engineer's approval prior to purchase, delivery, equipping, installation or implementation, without limitation, of the following: :

1. Identification of the Works and temporary signs.
2. Temporary Site offices and site laboratory, including laboratory equipment.
3. Site canteen including kitchen equipment
4. Site medical clinic including medical equipment for emergency cases.
5. Site mosque including ablution area
6. Storage and fabrication sheds.
7. Construction aids and miscellaneous services and facilities:

    a. Exterior scaffold system, including ladders, walkways, platforms and guardrails.
    b. Protective screens and chutes.
    c. Tower cranes.
    d. Lifts and hoists for materials and workmen.

M. The Engineer's site offices shall be completely detached from that of the Contractor's and shall be at a location as approved by the Engineer.

N. Drawings showing the plans and elevations shall be submitted to the Engineer for approval.

1. Any reasonable changes or modifications suggested by the Engineer shall be incorporated at no additional cost to the Employer.

O. Security and Protection Facilities: Submit detailed proposals including drawings, layout, details, and product data as requested; obtain the Engineer's approval prior to purchase, delivery, installation or implementation, as applicable, of the following:

1. Fire protection.
2. First Aid and Medical protection
3. Fences and Entrance Gates

1.5 QUALITY ASSURANCE

A. Electric Service: Comply with NECA, NEMA, and UL standards and regulations for temporary electric service. Install service to comply with NFPA 70.

B. Tests and Inspections: Arrange for authorities having jurisdiction to test and inspect each temporary utility before use. Obtain required certifications and permits.

C. Accessible Temporary Egress: Comply with applicable provisions in the United States Access Board's ADA-ABA Accessibility Guidelines and] ICC/ANSI A117.1.

D. Regulations: Comply with industry standards and applicable laws and regulations of authorities having jurisdiction including, but not limited to, the following:

1. Building code requirements.
2. Utility company regulations.
3. Police and fire department regulations.
4. Environmental protection regulations.
5. Fire and Life Safety Code of Practice.
6. Health and Safety regulations.
7. Airport Fire Fighting and Rescue Services.

E. Standards: Comply with Local Regulations, IEE, NEC, IEC and NFPA.

1.6 PROJECT CONDITIONS

A. Temporary Use of Permanent Facilities:

1. If required, engage Installer of each permanent service to assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Employer's acceptance, regardless of previously assigned responsibilities.
2. Take full responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before Taking Over, regardless of previously assigned responsibilities.

B. Temporary Utilities: At earliest feasible time, when accepted by the Engineer, change over from use of temporary service to use of permanent service.

C. Conditions of Use: The following conditions apply to use of temporary services and facilities by all parties engaged in the Works:

1. Keep clean and neat.
2. Operate in a safe and efficient manner.
3. Do not overload or permit them to interfere with progress.
4. Take appropriate fire prevention measures.
5. Do not allow hazardous, dangerous, or unsanitary conditions, or public nuisance to develop or persist on Site.
6. Relocate as required by progress of the Works.
7. Contractor's personnel and workmen, including subcontractors, are not permitted to use permanent toilet facilities or wash facilities.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide new materials suitable for use intended.

B. Construction Materials and Products: Comply with standards and applicable requirements in appropriate sections of the Specification.

C. Tarpaulins: Waterproof, fire-resistive, with low flame-spread rating.

D. Chain-Link Fencing: Minimum 50-mm, 3.8-mm thick, galvanized-steel, chain-link fabric fencing; minimum 1.8 m high with galvanized-steel pipe posts; minimum 60-mm OD line posts and 73-mm-OD corner and pull posts, with 42-mm OD top rails, with galvanized barbed-wire top strand.

E. Portable Chain-Link Fencing: Minimum 50-mm, 3.8-mm thick, galvanized-steel, chain-link fabric fencing; minimum 1.8 m high with galvanized-steel pipe posts; minimum 60-mm OD line posts and 73-mm OD corner and pull posts, with 42-mm OD top and bottom rails. Provide concrete bases for supporting posts.

F. Fencing Windscreen Privacy Screen: Polyester fabric scrim with grommets for attachment to chain-link fence, sized to height of fence, in color selected by the Engineer from manufacturer's standard colors.

G. Wood Enclosure Fence: Plywood**,** 1.8 m high, framed with four 50-by-100-mm rails, with preservative-treated wood posts spaced not more than 2.4 m apart.

H. Hoarding Fencing: Include minimum characteristics.

I. Polyethylene Sheet: Reinforced, fire-resistive sheet, 0.25-mm minimum thickness, with flame-spread rating of 15 or less in accordance with ASTM E84 and passing NFPA 701 Test Method 2.

J. Dust-Control Adhesive-Surface Walk-Off Mats: Provide mats, minimum 914 by 1524 mm.

K. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

L. Temporary Enclosures:

1. Translucent, fire-retardant, nylon-reinforced laminated polyethylene or polyvinyl chloride tarpaulins.
2. Only noncombustible panels, flame-resistant tarpaulins or approved materials of equivalent fire-retardant characteristics shall be used.
3. Any other fabrics or plastic films used shall be certified as conforming to the requirements of Test Method #2 contained in NFPA 701, Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.
4. Where used to enclose structures, forming equipment and similar items, the enclosing material shall be fastened securely or guarded by construction so it cannot be blown by the wind against heaters or other sources of ignition.
5. Temporary enclosures shall be equipped with at least one fire extinguisher suitable for all classes of Fires that are expected in that enclosure. Extinguishers shall comply with Fire and Life Safety Code of Practice.

M. Equipment / Motorized Equipment:

1. Internal combustion engines and associated equipment, such as air compressors, hoists, derricks, generators, pumps and similar devices shall be located so that the exhausts discharges well away from combustible materials, and shall be maintained regularly.
2. Where the exhausts are piped outside the structure under construction, alteration, or demolition, a clearance of at least 230 mm shall be maintained between such piping and combustible material.
3. Internal combustion engines and associated equipment shall be shut down and allowed to cool sufficiently prior to refueling.
4. Service areas for equipment shall not be located within structures under construction, alteration, or demolition.
5. Fuel for internal combustion engines shall not be stored within structures under construction, alteration, or demolition.

2.2 TEMPORARY FACILITIES

A. General:

1. Temporary Site Facilities shall be made of non-combustible material.
2. Separation distances between buildings under construction and construction-related structures, such as field offices, trailers, sheds, and other facilities for the storage of tools and materials having combustible construction or contents, shall be considered as per codes and standards.
3. Facilities shall not be stacked with one over the other, in whole or in part, unless the structure is designed and approved for such installation and permitted by the Engineer and the authority having jurisdiction.
4. Adequate detachment between temporary structures shall be provided to minimize spread of fire.
5. Adequate temporary fire detection, fixed fire protection systems and portable firefighting equipment shall be provided as required by Fire and Life Safety Code of Practice.
6. Only safely installed cooking appliances and methods shall be used in field offices and sheds.
7. Clearance shall be provided around stoves, heaters, and all chimney and vent connectors to prevent ignition of adjacent combustible materials.

8. The location of underground electrical cables, gas piping, water piping, and sewer lines that are buried within 1.2 m of the perimeter of the site's largest planned manufactured facility and shall be indicated by an aboveground sign(s) or underground marker tapes identifying the proximity of the lines.
9. A plot plan showing the “as built” location of underground utility lines shall be available for installations in multiple-site facilities.

B. Field Offices:

1. Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
2. Employer will provide conditioned interior space for field offices for duration of Project.

C. Common-Use Field Office:

1. Of sufficient size to accommodate needs of Employer, the Engineer, and construction personnel office activities and to accommodate Project meetings specified in other Division 01 Sections. Keep office well maintained, clean and orderly. Furnish and equip offices as follows:

    a. Furniture required for Project-site documents, including file cabinets, plan tables, plan racks, and bookcases.
    b. Conference room of sufficient size to accommodate meetings of ten (10) individuals. Provide electrical power service and 230 V ac or 240 V ac duplex receptacles, with no fewer than one receptacle on each wall. Furnish room with conference table, chairs, and 1.2-m- square tack and marker boards.
    c. Drinking water and private toilets for the use of Employer, the Engineer, and construction personnel.
    d. Heating and cooling equipment necessary to maintain a uniform indoor temperature 20 to 22 deg C.
    e. Lighting fixtures capable of maintaining average illumination of 215 lx at desk height.

2. Employer / Engineer Field Offices: Provide new office furniture and equipment suitable for use intended.

D. Temporary Site Offices:

1. Prefabricated, mobile units or job-built construction, with lockable entrances, operable windows, serviceable finishes and robust and secure fittings; insulated, weather tight, heated and air-conditioned.
2. Incorporate sanitary facilities to the extent required for the number and gender of personnel accommodated.
3. Support on foundations adequate for loading.
4. Provide and maintain all necessary and required services and utilities, including but not necessarily limited to:

    a. Sewers and drainage.
    b. Water service and distribution.
    c. Sanitary facilities, including toilets, wash facilities, and drinking-water facilities.
    d. Air-conditioner heating and cooling.
    e. Ventilation.
    f. Electric power service.
    g. Lighting.
    h. Telephone service.
    i. Firefighting appliances.

E. Janitorial services and facilities, and general attendance.

F. Computers for the Employer / Engineer:

1. New computer equipment and peripheral hardware, licensed software, Internet connection and associated accessories, including local area networking, computer workstations, mouse and keyboard and all necessary cabling as required.

2. PC: Acceptable Brand Name; each with:

    a. Processor: Intel Core i7 processor 14th Generation.
    b. Graphics: RTX 2000 ADA (16GB).
    c. Memory: 64GB RAM (2x32GB), DDR5, upgradable to 128GB.
    d. Storage: 1TB SSD.
    e. External I/O Ports: RJ45, HDMI, DP, USB-C, 4xUSB-A, combo jack for headphone/mic.
    f. Formfactor: Tower.
    g. Keyboard: English/Arabic, USB.
    h. Mouse: Optical, USB, scroll wheel.
    i. H/W Security features: TPM2.0.
    j. Operating System: Windows 11 Pro 64.
    k. Warranty/SLA: 3-years next business day response onsite desktop hardware support.

3. Monitor: Acceptable Brand Name; each with:

    a. Size: 24"
    b. Refresh Rate: 60 Hz or higher
    c. Panel Type: IPS
    d. Backlight: LED
    e. Aspect Ratio: 16:09
    f. Resolution: 1920x1080 pixel
    g. Contrast Ratio: 1000:01:00
    h. Response Time: 5ms or lower
    i. Input: DP, HDMI & DVI
    j. Brightness: 250 cd/m2
    k. Viewing Angle (H, V): 178° / 178°
    l. Speaker: Yes
    m. USB: Yes
    n. Maximum Power Consumption: 45w to 50 w
    o. Color Black
    p. Category Professional

4. Laptop: Acceptable Brand Name; each with:

    a. Processor: Intel Core i7 processor 14th Generation
    b. Graphics: Integrated
    c. Memory: 32 GB RAM (2 x 16 GB), upgradable to 64 GB
    d. Storage: 1TB PCIe NVMe 2 SSD
    e. Display: 14” touch screen
    f. Pen: Digital pen
    g. External I/O Ports: HDMI, USB-C Thunderbolt 4, USB-A, RJ45, fingerprint, combo jack for headphone/mic
    h. Webcam: Full HD webcam with privacy shutter
    i. Keyboard: English/Arabic backlit keyboard
    j. Wireless Technology: Intel Wi-Fi 6E AX211 (2x2) and Bluetooth 5.x latest wireless card (supporting gigabit data rate)
    k. Security Lock port: Yes. Combination cable lock to be quoted separately.
    l. H/W Security features: TPM2.0
    m. Operating System: Windows 11 Pro 64
    n. Weight: Below 1.4Kg
    o. Power Adapter: Slim Power Adapter
    p. Warranty/SLA: 3-years next business day response onsite notebook hardware support

5. Software: Original, latest Arabic / English version, multi-user licensed copies of the following software programs for specified operating system, together with user manuals:

    a. Windows 10 Professional
    b. MS Office 2019
    c. Adobe Reader
    d. 7 Zip
    e. Autodesk True view 2019
    f. Autodesk Navisworks freedom 2019
    g. PD Fill (File conversion)
    h. Anti-virus
    i. AUTODESK / Bently & other engineering software (upon request)

6. Printer / Photocopy machine (Multi-Function Printer):

    a. Function: Copying, faxing, printing, scanning & network scanning black & color
    b. Media size: A4 / A3
    c. Print Color speed: 40 -50 ppm
    d. Required monthly volume: 25000 or more
    e. Print resolution: 600x600 dpi minimum
    f. Duplex printing: Yes
    g. Trays Input: 100 sheets multi-purpose, 2x500 A4/A3
    h. RAM: 2 GB RAM minimum
    i. Hard drive: Yes
    j. Printer Language: HP PCL 5, HP PCL 6, Postscript Level 3
    k. Scanner type: Flatbed, Duplex ADF
    l. Scan resolution, optical: 600 dpi
    m. Scan size, maximum (flatbed & ADF): 11.7 x 17 in
    n. Scan speed: 40 ppm
    o. Digital sending features: Scan to Network Shared Folder, Send to Email
    p. File Formats: PDF, JPEG, TIFF
    q. Copy resolution: 600 x 600 dpi
    r. Copy reduce/enlarge settings: 25 to 400%
    s. Maximum number of copies: Up to 999 copies
    t. Connectivity, standard: USB 2.0, 10/100/1000 LAN
    u. Compatible operating systems: Windows (32Bit and 64-bit), Mac OS X; Linux
    v. Touch screen panel: Yes
    w. Print Management: Support Ringdale follow me print management solution - Support Pin code
    x. Card Reader Technology: Contact less
    y. Warranty & Support: 3 years Onsite

7. UPS Equipment to accommodate all the devices.

8. Computer Workstation, comprising:

    a. Desking with wire management; to accommodate PC, monitor, keyboard and mouse.
    b. Operator's swivel chair.

G. Vehicles for the Engineer:

1. New air-conditioned motor vehicles. Vehicles provided for the Engineer are the property of the Contractor and shall be returned to the Contractor at the times as indicated.
2. Vehicles: four-wheel drive 4WD.
3. Arrange for and pay all charges and costs arising in connection with the delivery, maintenance and running of vehicles, including but not limited to:

    a. Delivery charges, license fees, road taxes and certificates.
    b. Fully comprehensive insurance cover for any driver at all times.

c. Regular service maintenance and repairs as necessary to keep the vehicles at all times in good roadworthy condition.
d. Supply of fuel, lubricants, replacement parts and other consumables.

4. Provide an acceptable similar type of replacement vehicle during any period that a vehicle is unavailable for any reason, including maintenance and/or repair.

H. Vehicles for the Employer:

1. New air-conditioned motor vehicles. Vehicles provided for the Employer are the property of the Contractor and shall be returned to the Contractor at the times as indicated.
2. Vehicles: four-wheel drive 4WD.
3. Arrange for and pay all charges and costs arising in connection with the delivery, maintenance and running of vehicles, including but not limited to:

a. Delivery charges, license fees, road taxes and certificates.
b. Fully comprehensive insurance cover for any driver at all times.
c. Regular service maintenance and repairs as necessary to keep the vehicles at all times in good roadworthy condition.
d. Supply of fuel, lubricants, replacement parts and other consumables.

4. Provide an acceptable similar type of replacement vehicle during any period that a vehicle is unavailable for any reason, including maintenance and/or repair.

I. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment for construction operations.

1. Store combustible materials apart from building.

2.3 EQUIPMENT

A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

1. Comply with NFPA 10 and NFPA 241 for classification, extinguishing agent, and size required by location and class of fire exposure.

B. HVAC Equipment: Unless Employer authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.

1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
2. Heating, Cooling, and Dehumidifying Units: Listed and labeled for type of fuel being consumed, by a qualified testing agency acceptable to authorities having jurisdiction, and marked for intended location and application.
3. Permanent HVAC System: If Employer authorizes use of permanent HVAC system for temporary use during construction, provide filter with MERV of Eight (8) at each return-air grille in system and remove at end of construction and clean HVAC system as required in Section 017700 "Closeout Procedures".

C. Air-Filtration Units: Primary and secondary HEPA-filter-equipped portable units with four-stage filtration. Provide single switch for emergency shut off. Configure to run continuously.

D. Electrical Outlets: 240 V properly configured British Standard with 3 pins; equipped with ground-fault circuit interrupters, switch, and pilot light.

E. Power Distribution System Circuits: The wires, conduits, containment, and protection for sockets, air-conditioning units and other miscellaneous equipment shall comply with local regulations.

F. Temporary Site Toilets: Prefabricated, self-contained, single-occupant units of chemical, aerated recirculation, or combustion type; vented; fully enclosed with a glass-fiber-reinforced polyester shell or similar non-absorbent material.

G. Drinking-Water Fixtures: Containerized, tap-dispenser, bottled-drinking-water units, including paper cup supply.

1. Where power is accessible, provide electric water coolers to maintain dispensed water temperature at 7.2 to 12.7 deg C.

H. Hand Tools and Power Tools; Provide new tools. Check continuously their safe operation. Provide continuous maintenance. Remove from Site any suspiciously operating tool.

PART 3 - EXECUTION

3.1 TEMPORARY FACILITIES, GENERAL

A. Conservation: Coordinate construction and use of temporary facilities with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste.

1. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Employer's property.

3.2 INSTALLATION, GENERAL

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Works.

1. Locate facilities to limit site disturbance as specified in Section 011000 "Summary".

B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

C. Isolation of Work Areas in Occupied Facilities: Prevent dust, fumes, and odors from entering occupied areas.

1. Prior to commencing work, isolate the HVAC system in area where work is to be performed according to coordination drawings.
2. Disconnect supply and return ductwork in work area from HVAC systems servicing occupied areas.
3. Maintain negative air pressure within work area, using HEPA-equipped air-filtration units, starting with commencement of temporary partition construction, and continuing until removal of temporary partitions is complete.
4. Maintain dust partitions during the Work. Use vacuum collection attachments on dust-producing equipment. Isolate limited work within occupied areas using portable dust-containment devices.
5. Perform daily construction cleanup and final cleanup using approved, HEPA-filter-equipped vacuum equipment.

3.3 TEMPORARY UTILITY INSTALLATION

A. Engage an appropriate local utility company to install temporary service or connect to existing service. Where the utility company provides only part of the service, provide the remainder with matching, compatible materials and equipment. Comply with utility company requirements and recommendations.

1. Arrange with the utility company, the Engineer, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services.
2. Provide for adequate capacity and peak-demand or special load requirements at each stage of construction. Before temporary utility is available, provide trucked-in services if necessary.
3. Obtain any necessary easements to bring temporary utilities to Site.
4. Charges and Costs: Pay for all connections, service and user charges and costs arising in connection with the provision of temporary utilities.

B. Sewers and Drainage:

1. If sewers are available, provide temporary connections to remove effluent that can be discharged lawfully. If sewers are not available or cannot be used, provide drainage ditches, dry wells, stabilization ponds, and similar facilities. If neither sewers nor drainage facilities can be lawfully used for discharge of effluent, provide containers to remove and dispose of effluent off-site in a lawful manner.
2. Filter out excessive soil, construction debris, chemicals, oils, and similar contaminants that might clog sewers or pollute waterways before discharge.
3. Connect temporary sewers to the municipal system as directed by sewer department officials.
4. Maintain temporary sewers and drainage facilities in a clean, sanitary condition. After heavy use, restore normal conditions promptly.

C. Water Service:

1. Connect to Employer's existing water service facilities. Clean and maintain water service facilities in a condition acceptable to Employer. At Taking Over, restore these facilities to condition existing before initial use.
2. Install water service and distribution piping in sizes and pressures adequate for construction.
3. Sterilize temporary water piping before use.
4. Provide storage tanks and / or rubber hoses as necessary to serve Site.
5. If at any time, temporary water service supply is interrupted or inadequate for requirements, provide back-up storage and truck-in water supplies as necessary.
6. If water pressure is inadequate, provide pumps to supply a minimum of 200-kPa static pressure at highest point. Equip pumps with surge and storage tanks and automatic controls to supply water uniformly at reasonable pressures.

D. Sanitary Facilities:

1. Provide temporary toilets, wash facilities, safety shower and eyewash facilities and drinking-water fixtures. Comply with regulations, health codes and the Engineer directions for type, number, location, operation, and maintenance of facilities and fixtures.
2. Provide separate toilet facilities for male and female personnel.
3. Install where facilities will best serve the needs of the Works, including relocation whenever necessary.
4. Service and maintain, and keep clean, sanitary and orderly for use.
5. Provide toilet tissue, paper towels, paper cups, and similar disposable materials for each facility. Maintain adequate supply. Provide covered waste containers for disposal of used material.
6. Temporary Site Toilets: Install self-contained toilet units. Shield toilets to ensure privacy.
7. Wash Facilities: Install wash facilities supplied with potable water at convenient locations for personnel who handle materials that require wash-up. Dispose of drainage properly. Supply cleaning compounds appropriate for each type of material handled.

8. Drinking-Water Facilities: Install containerized, tap-dispenser, bottled-drinking-water units, including paper cup supply.
9. Toilets:

    a. Install toilet facilities connected to local water and sewer lines. Provide lavatories, mirrors, and water closets. Provide only potable-water connections. Provide individual compartments for water closets. Provide suitable enclosure with non-absorbent sanitary finish materials and adequate ventilation and lighting.

10. Wash Facilities:

    a. Install wash facilities supplied with potable water at convenient locations for personnel who handle materials that require wash-up. Dispose of drainage properly. Supply cleaning compounds appropriate for each type of material handled.

11. Drinking Water Facilities:

    a. Install containerized, tap-dispenser, bottled-drinking-water units, including paper cup supply and water bottles supply as needed.

E. Use of Permanent Toilets:

1. Use of Employer's existing or new toilet facilities is not permitted, unless if expressly stated otherwise by Employer upon certain conditions.

F. Temporary Heating and Cooling:

1. Select equipment from that specified that will not have a harmful effect on completed installations or elements being installed.

G. Ventilation and Humidity Control:

1. Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment from that specified that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.
2. Provide dehumidification systems when required to reduce substrate moisture levels to level required to allow installation or application of finishes.

H. Electric Power Service:

1. Provide weatherproof, grounded electric power service and distribution system of appropriate and sufficient size, capacity, and power characteristics required for use during construction, including necessary start-up, testing and commissioning of building operating systems and equipment. Include meters, transformers, overload-protected disconnecting means, automatic ground-fault interrupters, and main distribution switchgear.
2. Install power distribution wiring overhead and underground if required and rise vertically where least exposed to damage.
3. If at any time, temporary electric power service supply is interrupted or inadequate for requirements, provide and operate back-up electric generators as necessary.
4. Connect temporary service to Employer's existing power source, as directed by Employer and maintain equipment in a condition acceptable to Employer.

I. Electric Distribution:

1. Provide receptacle outlets adequate for connection of power tools and equipment.

2. Provide waterproof connectors to connect separate lengths of electrical power cords if single lengths will not reach areas where construction activities are in progress. Do not exceed safe length-voltage ratio.

J. Lighting:

1. Provide temporary lighting with appropriate control and local switching to facilitate safe and proper execution of the Works. Provide adequate illumination to internal areas during finishing operations and for construction operations, observations, inspections, and traffic conditions.
2. Install and operate temporary lighting that fulfills security and protection requirements without operating the entire system.
3. Install lighting for Works identification sign.

K. Telecom Service:

1. Provide and maintain adequate temporary telecom facilities and services in all common-use facilities for the duration of the Contract including Defects Liability Period, for all personnel accommodated in temporary field offices.
2. Install one (1) land-based telephone line(s) for each field office.
3. Provide and install a PABX in Engineer field offices and provide handsets in every office or occupied space.
4. Provide the following telephone facilities, line connections and services for the exclusive use of the Engineer and his staff.

    a. Two (2) land lines dedicated to PABX in Engineer field offices.
    b. One (1) land line dedicated to fax machine or modem in Engineer field offices.
    c. Twenty (20) cellular telephone lines and related smart phones.

5. Provide the following telephone facilities, line connections and services for the exclusive use of the Employer and his staff.

    a. One (1) land lines dedicated to PABX in Employer field office.
    b. One (1) land line dedicated to fax machine or modem in Employer field offices.
    c. Five (5) cellular telephone lines and related smart phones.

6. At each telephone, post a list of important telephone numbers.

    a. Police and fire departments.
    b. Ambulance service.
    c. Contractor's home office.
    d. Contractor's emergency after-hours telephone number.
    e. Engineer's office.
    f. Construction Manager's home office.
    g. Engineers' offices.
    h. Employer's office.
    i. Principal subcontractors' field and home offices.

7. Internet Service:

    a. Provide Multi-user high-speed internet subscription from an approved local Internet Service Provider (ISP).
    b. Ensure the setup includes a broadband modem and a router with a business-grade hardware firewall.
    c. Provide a minimum upload and download speed of 30Mbps / 30Mbps for shared use by up to 15 employees for basic internet browsing service. The baseline speed must be reviewed and increased as necessary based on the additional internet services required (collaboration tools, file transfer, cloud applications, etc.). Services requiring

dedicated bandwidth should be identified, and appropriate Quality of Service (QoS) settings must be implemented to ensure reliable performance.

d. Provide a hardware firewall that must include advanced security features, such as intrusion detection and prevention systems (IDS/IPS), Web Filter, certificate inspection, etc.

e. Provide a reliable and secure WiFi network for all temporary facilities, accessible to both the Engineer and the Employer. The WiFi system should ensure strong signal coverage throughout all areas, eliminating any connectivity dead zones. WiFi security must be maintained with WPA3 encryption, strong passwords that are regularly updated, and network segregation to create separate networks for contractor personnel and Engineer / Employer users, ensuring privacy and security.

L. Project Computer:

1. Provide One (1) desktop computer in the primary field office adequate for use by the Engineer and Employer to access Project electronic documents and maintain electronic communications.
2. Backup: External hard drive, minimum 1000 gigabyte, with automated backup software providing daily backups.

3.4 SUPPORT FACILITIES INSTALLATION

A. Comply with the following:

1. Provide construction for temporary field offices, shops, and sheds located within construction area or within 9 m of building lines that is noncombustible in accordance with ASTM E136. Comply with NFPA 241.
2. Utilize designated area within existing building for temporary field offices.
3. Maintain support facilities until the Engineer schedules Substantial Completion inspection. Remove before Substantial Completion. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Employer.

B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations and able to withstand heavy construction vehicles load. Provide road signs and safety barriers as needed. Locate temporary roads and paved areas as indicated on Drawings.

1. Provide dust-control treatment that is nonpolluting and noncracking. Reapply treatment as required to minimize dust.

C. Temporary Use of Planned Permanent Roads and Paved Areas: Locate temporary roads and paved areas in same location as permanent roads and paved areas. Construct and maintain temporary roads and paved areas adequate for construction operations. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.

1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
2. Prepare subgrade and install subbase and base for temporary roads and paved areas in accordance with Section 312000 "Earth Moving."
3. Recondition base after temporary use, including removing contaminated material, regrading, proof rolling, compacting, and testing.
4. Delay installation of final course of permanent hot-mix asphalt pavement until immediately before Substantial Completion. Repair hot-mix asphalt base-course pavement before installation of final course in accordance with Section 321216 "Asphalt Paving."

D. Traffic Controls: Comply with requirements of authorities having jurisdiction.

1. Protect existing site improvements to remain, including curbs, pavement, and utilities.

2. Maintain access for fire-fighting equipment and access to fire hydrants.

E. Parking: Comply with the following:

1. Provide temporary offsite parking areas for construction personnel, unless otherwise stated by Employer.
2. Provide shaded parking locations for all Engineer’s vehicles.
3. Provide shaded parking locations for all Employer’s vehicles.
4. Temporary car-port shade structures for [five (5)] vehicles adjacent to the Employer / Engineer field offices, including temporary paved vehicular access, car-port hard-standing and walkways.

F. Storage and Staging: Provide temporary offsite area for storage and staging needs.

G. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. Maintain Project site, excavations, and construction free of water.

1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties or endanger permanent Work or temporary facilities.
2. Remove snow and ice as required to minimize accumulations.

H. Project Signs: Provide Project signs as indicated. Unauthorized signs are not permitted.

1. Identification Signs: Provide Project identification signs as indicated on Drawings.
2. Temporary Signs: Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.
3. Provide temporary, directional signs for construction personnel and visitors.
4. Maintain and touch up signs, so they are legible at all times.

I. Waste Disposal Facilities: Comply with requirements specified in Section 017419 "Construction Waste Management and Disposal."

J. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with the requirements of authorities having jurisdiction. Comply with progress cleaning requirements in Section 017300 "Execution."

K. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.

L. Temporary Elevator Use: Use of elevators is not permitted.

M. Existing Elevator Use: Use of Employer's existing elevators will be permitted, provided elevators are cleaned and maintained in a condition acceptable to Employer. At Substantial Completion, restore elevators to condition existing before initial use, including replacing worn cables, guide shoes, and similar items of limited life.

1. Do not load elevators beyond their rated weight capacity.
2. Provide protective coverings, barriers, devices, signs, or other procedures to protect elevator car and entrance doors and frame. If, despite such protection, elevators become damaged, engage elevator Installer to restore damaged work, so no evidence remains of correction work. Return items that cannot be refinished in field to the shop, make required repairs and refinish entire unit, or provide new units as required.

N. Temporary Stairs: Until permanent stairs are available, provide temporary stairs where ladders are not adequate.

O. Existing Stair Usage: Use of Employer's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to Employer. At Substantial Completion, restore stairs to condition existing before initial use.

1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas, so no evidence remains of correction work.

P. Temporary Use of Permanent Stairs: Use of new stairs for construction traffic will be permitted, provided stairs are protected and finishes restored to new condition at time of Substantial Completion.

Q. Site Field Offices - General: comply with the following:

1. Provide continued maintenance, support and service, including final removal.
2. Supplement, extend, relocate, modify, alter and adapt as necessary to comply with requirements indicated and specified, and accommodate construction operations under this Contract.
3. Locate field offices, site laboratory, site clinic, mosque canteen, storage and fabrication sheds, workshops, sanitary facilities, and other temporary construction and support facilities for easy access.
4. Maintain support facilities until six months after Substantial Completion. Unless otherwise directed, remove after six months after Substantial Completion, but retain adequate support facilities to accommodate personnel remaining on Project site during defect liability period and after six months of Substantial Completion, including relocating if necessary and under conditions acceptable to Employer.

R. Contractor's Field Offices: Provide and maintain temporary field offices and facilities of sufficient size, number and type to accommodate required office personnel, including sub-contractors, at the Project site. Furnish and equip as necessary. Keep clean and orderly for use.

S. Site Laboratory: Provide temporary site laboratory facility of sufficient size to accommodate, conduct, perform and report on-site sampling and testing of materials as prescribed and specified in various Sections of the Project Specification. Furnish and equip as necessary. Keep clean and orderly for use.

1. Employ qualified laboratory technicians familiar with specified industry standards and skilled in the testing of construction materials and associated administrative procedures.

T. Temporary Site Medical Clinic: Provide, maintain, and equip a medical clinic of appropriate area for providing basic and emergency medical treatment for work force expected for the construction of the Contract. The clinic shall be fully furnished with appropriate furniture with all electromechanical works including telephones and Data network and sockets in all appropriate locations. Provide and maintain medical equipment and accessories. [Provide shaded parking for one (1) Ambulance and for ten (10) vehicles.]

1. The following is an indicative space program:

   a. Reception area, Waiting area, Doctor rooms, Patient rooms, Medical inspection room, Pharmacy, Ambulance staff room, Ambulance parking area Electro-Mechanical area.

2. Employ qualified doctors, personnel’s familiar and skilled in the medical field.
3. Provide continued services, maintenance, support and provide continued medical services with medicine, first aid, including final removal.

U. Site Mosque: Provide, maintain, and equip a temporary field mosque of sufficient size, number and type to accommodate around 100 persons, Furnish and equip as necessary. Keep clean and orderly for use. The mosque shall include an appropriate number of toilets ablution facilities,

V. Site Canteen: Provide, maintain, and equip site canteen of sufficient size to serve meals and snack for workers and management staff. Design, construct, and furnish two (2) canteens one for senior management staff and general workers (respectively) the size of the canteen shall be appropriate to accommodate his workers staff.

1. The following is an indicative space program:

    a. Dining area, Kitchen and food preparation area, Food serving area (self-service), storage areas, Dry storage area, cold storage area, deep, freezer area, Services, Electro-Mechanical areas.

W. Employer / Engineer Field Offices: Provide and maintain temporary offices, and facilities for the exclusive use of the Employer / Engineer and his staff, sized, arranged, furnished and equipped to the approval of the Engineer.

1. Provide continued maintenance, support and service, including final removal.
2. Supplement, extend, relocate, modify, alter and adapt as necessary to comply with requirements indicated and specified, and accommodate construction operations under this Contract.

X. Employer / Engineer Temporary Offices: Provide and maintain temporary offices, and facilities for the exclusive use of the Employer / Engineer and his staff, sized, arranged, furnished and equipped to the approval of the Employer/Engineer. The Contractor shall provide a layout for the Employer's / Engineer's field offices showing the design layout with the necessary circulation areas and the proposed furniture and equipment for the approval of the Engineer. The following are the minimum requirements.

1. One (1) General Reception area sized and arranged to receive visitors; with:

    a. 1 reception desk and 1 swivel armchair.
    b. 4 office armchairs.
    c. 2 side coffee tables
    d. 2 pin boards.
    e. 2 wastepaper baskets.

2. One (1) Engineer Office, approximately 4 m x 6 m; with:

    a. 1 double pedestal desk with lockable drawers and 1 swivel armchair.
    b. 1 conference table and 6 office armchairs.
    c. 1 layout reference table.
    d. 2 lockable steel filing cabinets.
    e. 1 lockable drawing hanger for 10 sets.
    f. 1 shelf unit.
    g. 2 pin boards.
    h. 2 wastepaper baskets.

3. One (1) Employer Office, approximately 4 m x 6 m; with:

    a. 1 double pedestal desk with lockable drawers and 1 swivel armchair.
    b. 1 conference table and 6 office armchairs.
    c. 1 layout reference table.
    d. 2 lockable steel filing cabinets.
    e. 1 lockable drawing hanger for 10 sets.
    f. 1 shelf unit.
    g. 2 pin boards.
    h. 2 wastepaper baskets.

4. Three (3) Staff Offices, each approximately 4 m x 4 m; each with:

    a. 1 desk with lockable drawers and 2 swivel armchairs.
    b. 1 office chairs.
    c. 1 layout reference tables.
    d. 1 lockable steel filing cabinets.
    e. 1 lockable drawing hanger for 10 sets.

f. 2 shelf units.
g. 1 pin boards.
h. 1 wastepaper baskets.

5. Four (4) Staff Offices, each approximately 4 m x 5 m; each with:

a. 2 desks with lockable drawers and 2 swivel armchairs.
b. 2 office chairs.
c. 2 layout reference tables.
d. 2 lockable steel filing cabinets.
e. 1 lockable drawing hanger for 10 sets.
f. 2 shelf units.
g. 2 pin boards.
h. 2 wastepaper baskets.

6. One (1) Secretarial Office, approximately 4 m x 6 m; with:

a. 1 secretary's workstation desk and 1 swivel armchair.
b. 6 office chairs.
c. 2 layout reference tables.
d. 2 large lockable steel filing cabinets.
e. 2 shelf units.
f. 2 pin boards.
g. 2 wastepaper baskets.
h. 10 desktop calculators.
i. 1 photocopy machine with A3 / A4 enlargement / reduction facility, automatic document feeder and collator.
j. 1 plain paper fax machine.
k. Regularly service and maintain office machines and equipment in good serviceable condition. Provide and continuously stock offices with all associated consumables, and supplies as and when required or requested, including stationery and papers.

7. One (1) Conference Room, sized to accommodate Project meetings for 14 people; with:

a. 1 conference table to seat 14 people.
b. 16 office armchairs.
c. 2 layout reference tables.
d. 2 shelf units.
e. 4 pin boards.
f. 1 blackboard.
g. 2 wastepaper baskets.

8. One (1) Multi-Purpose Room, 8 m x 4 m; with:

a. 10 office chairs.
b. 10 layout reference tables.
c. 6 shelf units.
d. 6 pin boards.
e. 10 wastepaper baskets.

9. One (1) Store Rooms; 4 m x 4 m; with:

a. Heavy duty shelf racking units.
b. Drawing hangers and racks.

10. Two (2) Toilets; each with:

a. WC suite.
b. Toilet roll holder.

c. Lavatory basin.
d. Mirror and shelf.
e. Paper towel dispenser.
f. Soap dispenser.
g. Waste bin with cover.
h. Service, maintain and clean toilets on a daily basis. Provide and continuously stock with all associated consumable and supplies as and when required or requested, including soaps, toilet paper and paper towels.

11. One (1) Kitchen; with:

a. 1 refrigerator 14 cu.ft. capacity.
b. 2 electric boiling rings.
c. 1 water filter and 1 twenty litre bottled-drinking-water dispenser — hot / cold.
d. 1 large waste bin with cover.
e. Kitchen base cabinets incorporating heat resistant worktop and stainless-steel sink / drainer.
f. Kitchen wall cabinets.
g. Sets of crockery and cutlery sufficient for number of the Employer / Engineer staff and visitors.
h. Service, maintain and clean kitchens on a daily basis. Provide and continuously stock with all associated consumables and supplies as and when requested or required, including drinking water, milk, sugar, tea and coffee beverages.

Y. Computers for the Employer / Engineer: Locate in the Employer / Engineer field offices. Install, connect and configure hardware and install software as directed, including interface with existing computer installations to provide a complete and fully operational, single network, computer system installation, to the satisfaction of the Employer / Engineer:

1. Ten (10) PC's.
2. Two (2) Laptop's.
3. UPS Equipment: Supplement and extend existing UPS as required to provide minimum Eight (8)) hour back-up for the entire computer system installation, new and existing.
4. Software: As specified.
5. Internet Connection: As specified.
6. Ten (10) computer workstations.
7. Regularly service, and maintain new computer equipment and combined system installations in serviceable and operable condition.

Z. Vehicles for the Employer / Engineer: Deliver to the Employer / Engineer within 7 days of the Commencement Date, together with spare keys, registration papers, insurance certificate and other related documentation:

1. Three (3)Vehicles four-wheel drive 4WD.
2. Employ and assign a full-time competent driver to each vehicle during normal working hours. Outside the working hours, the vehicles shall remain under the Contractor’s custody.
3. Vehicles shall, unless otherwise indicated, be returned to the Contractor within one month after the date of issue of the Taking-Over Certificate for the whole of the Work.

AA. Temporary Roads and Paved Areas: Construct and maintain temporary asphalted roads and paved areas adequate to support loads and to withstand exposure to traffic during construction period. Submit proposals and obtain prior approval from the Engineer for the proposed location of temporary roads and paved areas. Coordinate elevation of temporary roads and paved areas. Provide and prepare sub-grade. Install subbase and base and hot mixed asphalt pavement. Comply with applicable requirements in appropriate sections of the Specification for sub-grade, sub-base, and base course. Finish asphalted courses construction of temporary road and paving areas.

1. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations, including delivery and storage of materials, equipment usage, administration and supervision.

BB. Traffic Controls: Comply with the requirements of authorities having jurisdiction. Include warning signs for public traffic and "STOP" signs for entrance onto public roads. Comply with the requirements of authorities having jurisdiction.

1. Protect existing site improvements to remain including curbs, pavement, and utilities.
2. Maintain access for fire-fighting equipment and access to fire hydrants.

CC. Dewatering Facilities and Drains: Comply with requirements of authorities having jurisdiction. in applicable specification Sections for temporary drainage and dewatering facilities and operations not directly associated with construction activities included in individual sections. Where feasible, use same facilities Maintain Project site, excavations, and construction free of water.

1. Dispose of rainwater in a lawful manner that will not result in flooding Project or adjoining properties nor endanger permanent Work or temporary facilities.

DD. Project Identification and Temporary Signs: Provide and install Project identification name board, size and lettering and supports are subject approval of the Engineer. Install signs to inform public generally and persons seeking entrance to Project. Do not permit the installation of unauthorized signs.

1. Design, fabricate and erect two (2) project identification signs in approved locations. Support on posts or framing of finished paint, preservative-treated wood or galvanized steel.
2. Engage an experienced sign manufacturer to apply graphics for Project identification signs related to this package. Write sign in English and use as applicable , and include:

    a. Project name.
    b. Employer's name, style and logo.
    c. Engineer name, style and logo
    d. Contractor's name, style and logo.
    e. Such other names, details and information as permitted and/or directed.

3. Provide other appropriate temporary signs to provide directional and safety information to construction personnel and visitors.
4. Maintain and touchup signs so they are legible at all times.

EE. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with the requirements of authorities having jurisdiction. Comply with Division 01 Section "Execution" for progress cleaning requirements.

FF. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.

1. Truck cranes and similar devices used for hoisting materials are considered tools and equipment and not temporary facilities.

GG. Janitorial Services: Provide janitorial cleaning services on a daily basis for all field offices, toilets, wash facilities, and similar areas.

HH. Storage and Fabrication Sheds: Provide sheds sized, furnished, and equipped to accommodate materials and equipment involved, including temporary utility services. Sheds may be open shelters or fully enclosed spaces within building or elsewhere on-site.

II. Construction Aids and Miscellaneous Facilities: Provide all necessary aids and miscellaneous facilities incidental and ancillary to the safe and efficient execution of construction operations and the carrying out of work in a proper workmanlike manner, including but not necessarily limited to:

1. Individual Project circumstances may require use of other aids and facilities, such as swing stages, ramps and bridges, incidental sheeting and shoring, and demolition waste chutes.
2. Scaffolds, ladders, walkways, platforms and guardrails.

    a. Protective screens, chutes, coverings and roofs.
    b. Small tools; hand and power operated.
    c. Mechanical plant, machinery and equipment; stationary and mobile.
    d. Tower cranes.
    e. Truck mounted cranes.
    f. Transportation equipment and vehicles; on and off Site.
    g. Lifts and hoists for materials and workmen.
    h. Protective clothing, including helmets, goggles, ear protectors and steel-toed safety boots.

JJ. Individual Project circumstances may require use of other construction aids and miscellaneous facilities, such as scaffolds, platforms, swing stages, ramps and bridges, incidental sheeting and shoring, and demolition waste chutes.

3.5 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Protection of Existing Facilities: Protect existing vegetation, equipment, structures, utilities, and other improvements at Project site and on adjacent properties, except those indicated to be removed or altered. Repair damage to existing facilities.

1. Where access to adjacent properties is required in order to affect protection of existing facilities, obtain written permission from adjacent property Employer to access property for that purpose.

B. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction as required to comply with environmental regulations and that minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects. Avoid using tools and equipment that produce harmful noise. Restrict use of noisemaking tools and equipment to hours that will minimize complaints and nuisance to persons or establishments near Site.

1. Comply with work restrictions specified in Section 011000 "Summary."

C. Temporary Erosion and Sedimentation Control: Comply with requirements of EPA Construction General Permit or authorities having jurisdiction, whichever is more stringent and requirements specified in Section 311000 "Site Clearing."

D. Temporary Erosion and Sedimentation Control: Provide measures to prevent soil erosion and discharge of soil-bearing water runoff and airborne dust to undisturbed areas and to adjacent properties and walkways, according to erosion and sedimentation-control Drawings.

1. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross tree- or plant-protection zones.
2. Inspect, repair, and maintain erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
3. Clean, repair, and restore adjoining properties and roads affected by erosion and sedimentation from Project site during the course of Project.
4. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

E. Stormwater Control: Comply with requirements of authorities having jurisdiction. Provide barriers in and around excavations and subgrade construction to prevent flooding by runoff of stormwater from heavy rains.

F. Tree and Plant Protection: Install temporary fencing located as indicated or outside the drip line of trees to protect vegetation from damage from construction operations. Protect tree root systems from damage, flooding, and erosion. Comply with requirements specified in Section 015639 "Temporary Tree and Plant Protection."

G. Pest Control: Engage pest-control service to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests and to perform extermination and control procedures at regular intervals, so Project will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using materials approved by authorities having jurisdiction.

H. Site Enclosure Fence: Prior to commencing earthwork, furnish and install site enclosure fence in a manner that will prevent people from easily entering site except by entrance gates.

1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient to accommodate construction operations.
2. Option in subparagraph below is only for projects connected to existing construction.
3. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Furnish one set of keys to Employer.

I. Security Enclosure and Lockup: Install temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security. Lock entrances at end of each workday.

1. Secure Storage: Where materials and/or equipment are of high value or attractive for theft, provide a secure lockup. Enforce discipline in connection with the installation and release of such materials and / or equipment to minimize the opportunity for theft.
2. Vertical Openings: Close openings of 2.5 m² or less with plywood or similar materials.
3. Horizontal Openings: Close openings in floor or roof decks and horizontal surfaces with load bearing, wood-framed construction.
4. Install tarpaulins securely using fire-retardant-treated wood framing and other materials.

J. Barricades, Warning Signs, and Lights: Comply with requirements of authorities having jurisdiction for erecting structurally adequate barricades, including warning signs and lighting.

K. Temporary Egress: Provide temporary egress from existing occupied facilities as indicated and as required by authorities having jurisdiction. Provide signage directing occupants to temporary egress.

L. Covered Walkway: Erect protective, covered walkway for passage of individuals through or adjacent to Project site. Coordinate with entrance gates, other facilities, and obstructions. Comply with regulations of authorities having jurisdiction and requirements indicated on Drawing**s.**

1. Provide overhead decking, protective enclosure walls, handrails, barricades, warning signs, exit signs, lights, safe and well-drained walkways, and similar provisions for protection and safe passage.
2. Paint and maintain appearance of walkway for duration of the Work.

M. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction operations, and similar activities. Provide temporary weathertight enclosure for building exterior.

1. Where heating or cooling is needed and permanent enclosure is incomplete, insulate temporary enclosures.

N. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by Employer and tenants from fumes and noise.

1. Construct dustproof partitions with gypsum wallboard, with joints taped on occupied side, and fire-retardant-treated plywood on construction operations side.

2. Construct dustproof partitions with two layers 0.14-mm polyethylene sheet on each side. Cover floor with two layers of 0.14-mm polyethylene sheet, extending sheets 460 mm up the sidewalls. Overlap and tape full length of joints. Cover floor with fire-retardant-treated plywood.
3. Construct vestibule and airlock at each entrance through temporary partition with not less than 1219 mm between doors. Maintain water-dampened foot mats in vestibule.
4. Where fire-resistance-rated temporary partitions are indicated or are required by authorities having jurisdiction, construct partitions according to the rated assemblies.
5. Insulate partitions to control noise transmission to occupied areas.
6. Seal joints and perimeter. Equip partitions with gasketed dustproof doors and security locks where openings are required.
7. Protect air-handling equipment.
8. Provide walk-off mats at each entrance through temporary partition.

O. Temporary Fire Protection: Until fire-protection needs are supplied by permanent facilities, install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241; manage fire-prevention program. Strictly observe all requirements and recommendations pertaining to fire safety on construction sites.

1. Provide fire extinguishers, installed on walls on mounting brackets, visible and accessible from space being served, with sign mounted above.

    a. Field Offices: Class A stored-pressure water-type extinguishers.
    b. Other Locations: Class ABC dry-chemical extinguishers or a combination of extinguishers of NFPA-recommended classes for exposures.

2. Locate fire extinguishers where convenient and effective for their intended purpose. Provide not less than one extinguisher on each floor at or near each usable.
3. Prohibit smoking in construction areas. Comply with additional limits on smoking specified in other Sections.
4. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition in accordance with requirements of authorities having jurisdiction.
5. Develop and supervise an overall fire-prevention and protection program for personnel at Project site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
6. Provide temporary standpipes and hoses for fire protection. Hang hoses with a warning sign, stating that hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.

3.6 MOISTURE AND MOLD CONTROL

A. Contractor's Moisture-Protection Plan: Avoid trapping water in finished work. Document visible signs of mold that may appear during construction.

B. Moisture and Mold Protection: Protect stored materials and installed Work in accordance with Moisture and Mold Protection Plan.

C. Exposed Construction Period: Before installation of weather barriers, when materials are subject to wetting and exposure and to airborne mold spores, protect as follows:

1. Protect porous materials from water damage.
2. Protect stored and installed material from flowing or standing water.
3. Keep porous and organic materials from coming into prolonged contact with concrete.
4. Remove standing water from decks.
5. Keep deck openings covered or dammed.

D. Partially Enclosed Construction Period: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:

1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
2. Keep interior spaces reasonably clean and protected from water damage.
3. Periodically collect and remove waste containing cellulose or other organic matter.
4. Discard or replace water-damaged material.
5. Do not install material that is wet.
6. Discard and replace stored or installed material that begins to grow mold.
7. Perform work in a sequence that allows wet materials adequate time to dry before enclosing the material in gypsum board or other interior finishes.

E. Controlled Construction Period: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:

1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
2. Use temporary or permanent HVAC system to control humidity within ranges specified for installed and stored materials.
3. Comply with manufacturer's written instructions for temperature, relative humidity, and exposure to water limits.
4. Hygroscopic materials that may support mold growth, including wood and gypsum-based products, that become wet during the course of construction and remain wet for forty-eight (48) hours are considered defective and require replacing.
5. Measure moisture content of materials that have been exposed to moisture during construction operations or after installation. Record readings beginning at time of exposure and continuing daily for forty-eight (48) hours. Identify materials containing moisture levels higher than allowed. Report findings in writing to the Engineer.
6. Remove and replace materials that cannot be completely restored to their manufactured moisture level within forty-eight (48) hours.

3.7 OPERATION, TERMINATION, AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. To minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

B. Maintenance: Maintain facilities in good operating condition until removal.

1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24-hour basis where required to achieve indicated results and to avoid possibility of damage.

C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.

D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are property of Contractor. Employer reserves right to take possession of Project identification signs.
2. Remove temporary roads and paved areas not intended for or acceptable for integration into permanent construction. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other

substances that might impair growth of plant materials or lawns. Repair or replace street paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.

3. At Substantial Completion, repair, renovate, and clean permanent facilities used during construction period. Comply with final cleaning requirements specified in Section 017700 "Closeout Procedures".

3.8 WILD AIR

A. Provision of Wild Air: Execute of part of the HVAC installations, such as the chillers, pumps, piping, main air handling units and main ductwork, to ensure sufficient elements of the HVAC installations can be operated to provide conditioned air to control the environment during the period when internal finishing works and decorations, susceptible to environmental temperature and humidity variations, are being executed prior to the Works being considered substantially complete. The HVAC equipment required to provide this Wild Air shall utilize temporary power sources if permanent power is not available during the period when the Wild Air is required.

B. Provision of Wild Air shall be executed in the following sequence:

1. Pressure testing of pipework and ductwork as specified.
2. Inspection of installations including power termination and safety control devices.
3. Energizing power supply panels.
4. Chemical flushing of chilled water system.
5. Internal cleaning of air handling equipment and ductwork to remove dust and debris.
6. Startup air handling equipment with necessary safety controls.
7. Startup chilled water plant with necessary safety controls.
8. Operate and maintain all equipment in good operating condition including routine maintenance and provision of all necessary spares and consumables.

C. Provide Wild Air by alternative means and methods, as required to suit Contractor’s scheduling and sequencing, where the specified sequence cannot reasonably be followed. Implement such alternatives at no additional time and cost to the Employer, and without relieving Contractor of any obligations under the Contract Documents.

D. Provide Wild Air supply, complete, including all temporary modifications to permanent systems and all required temporary power and power sources. Include all associated labor, materials, equipment, and incidentals as part of the Works.

END OF SECTION 015000

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SECTION 015639 - TEMPORARY TREE AND PLANT PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, and Division 01 Specification Sections, apply to this Section.

B. EIS/EISA and any similar or related Environmental and Ecological surveys, studies, and reports available such as CEMP and the like including the need to consider both flora and fauna in any site assessment and planning.

C. Geotechnical studies and reports that may provide useful information and data concerning soil profiles, composition, and analysis as well as the presence of ground water.

1.2 SUMMARY

A. Section includes general protection, and retention as required of existing trees and plants that are affected by execution of the Work, whether temporary or permanent construction. It provides guidance for owners, developers, architects, landscape architects, designers, advisors, engineers, planners, contractors, surveyors, botanists, ecologists, arborists, and horticultural professionals concerned with the care and protection of trees and other significant vegetation, and any parties interested in the integration between trees and construction.

B. Related Requirements:

1. Division 01 Section 015000 "Temporary Facilities and Controls" for temporary controls, utilities, support facilities, temporary site fencing, and, if applicable, temporary erosion- and sedimentation-controls if not specified in Section 311000 "Site Clearing".
2. Division 31 Section 311000 "Site Clearing" for removing existing trees and shrubs and for temporary erosion- and sedimentation-control measures if not specified in Section 015000 "Temporary Facilities and Controls".
3. Division 32 Section 329600 "Transplanting" for relocating existing trees and plants.

1.3 DEFINITIONS

A. Caliper: Diameter of a trunk measured by a diameter tape at a height 150 mm above the ground for trees up to and including 100-mm size at this height and as measured at a height of 300 mm above the ground for trees larger than 100-mm size.

B. Caliper (DBH): Diameter breast height; diameter of a trunk as measured by a diameter tape a height 1372 mm above the ground line for trees with caliper of 200 mm or greater as measured at a height of 300 mm above the ground.

C. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected prior to, during, and after construction and indicated on Drawings.

D. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected prior to, during, and after construction and indicated on Drawings or defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated or defined by a circle concentric with each tree with a radius 12 times the tree's caliper size and with a minimum radius of 2400 mm unless otherwise indicated.

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E. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

1.4 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site

1. Review methods and procedures related to temporary tree and plant protection including, but not limited to, the following:

    a. Tree-service firm’s personnel, and equipment needed to make progress and avoid delays.
    b. Arborist's responsibilities.
    c. Quality-control program.
    d. Coordination of Work and equipment movement with the locations of protection zones.
    e. Enforcing requirements for protection zones.
    f. Trenching by hand or with air-spade within protection zones.
    g. Field quality control.
    h. No objection or Authority permits and approvals.

B. Prior to meeting, mark all trees and plants to remain and or to be removed, for review and approval by Employer’s Representative.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:

1. Include plans, elevations, sections, and locations of protection-zone fencing and signage, showing relation of equipment-movement routes and material storage locations with protection zones.
2. Detail fabrication and assembly of protection-zone fencing and signage.
3. Indicate extent of trenching by hand or with air-spade within protection zones.

C. Samples: For each type of the following:

1. Organic Mulch: 0.5-L or 1-L (as required by Engineer) volume of organic mulch; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch.
2. Protection-Zone Fencing: Assembled Samples of manufacturer's standard size made from full-size components
3. Protection-Zone Signage: Full-size Samples of each size and text, ready for installation.

D. Tree Pruning Schedule: Written schedule detailing scope and extent of approved pruning of trees to remain that interfere with or are affected by construction.

1. Species and size of tree.
2. Location on site plan. Include unique identifier for each.
3. Reason for pruning.
4. Description of pruning to be performed.
5. Description of maintenance following pruning.

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1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified arborist and tree service firm.

B. Certification: From arborist, certifying that trees indicated to remain have been protected prior to, during, and after construction in accordance with recognized standards, and that trees were promptly and properly treated and repaired when damaged.

C. Maintenance Recommendations: From arborist, for care and protection of trees affected by construction during and after completing the Work.

D. Existing Conditions: Documentation of existing trees and plantings indicated to remain, which establishes preconstruction conditions, to be considered by all other site contractors.

1. Use sufficiently detailed photographs or video recordings.
2. Label each photograph or video with both plant botanical and common names, location on site, and date of photograph or video recordings.
3. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.

E. Quality-control program.

1.7 QUALITY ASSURANCE

A. Product and Equipment shall demonstrate compliance with requirements specified in Division 01 Section 016000 "Product Requirements", and with sustainability targets and requirements specified in Division 01 Sections and in other Divisions' related Sections for Sustainability Design Requirements, as applicable.

B. Arborist Qualifications: Certified Arborist as certified by ISA

C. Tree-Service Firm Qualifications: A qualified and experienced landscaping contractor approved by the Authority Having Jurisdiction where Project is located, with a minimum 15 years of documented experience in similar types of projects, including undertaking at least 5 successful temporary tree and plant protection works of similar scope, complexity, and environmental condition to that required for this Project, within the past [**5**] years, and that will assign an experienced, qualified arborist to the Project site during execution of the Works.

D. Tree Workers Qualifications: Pruning shall be performed only by qualified experienced, and competent arborist.

E. Quality-Control Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Works without damaging trees and plantings. Include dimensioned diagrams for placement of protection zone fencing and signage, the arborist and tree-service firm's responsibilities, instructions given to workers on the use and care of protection zones, and enforcement of requirements for protection zones.

1.8 FIELD CONDITIONS

A. The following practices are prohibited within protection zones:

1. Storage or stockpiling of construction materials, debris, or excavated material.
2. Dumping of poisonous materials on or around trees and plants' roots. Such material includes but is not limited to paint, petroleum products, cement and concrete products,

contaminated water, or any material that may be harmful to tree health and/or result in permanent soil contamination.
3. Moving, parking or storing vehicles or equipment.
4. Damage to roots, bark, trunk, limbs, or foliage.
5. Soils disturbance, compaction, topsoil removal, surface treatment, construction activity, or grade change.
6. Foot traffic.
7. Erection of sheds or structures, or location of temporary facilities including trailers or portable toilets.
8. Excessive unintended water, or applications of untreated water.
9. Wash down and cleaning of equipment.
10. Changes to natural overland water flow or drainage.
11. Alteration of the water table; either raising or lowering.
12. Excavation, trenching, or other digging unless otherwise indicated and methodology approved by Employer based on arborist advice.
13. Attachment of signs to or wrapping materials around trees or plants, or use of trees as support, backstops, poles, unless otherwise indicated.
14. Cultivation.
15. Refueling.
16. Preparation of chemicals, including preparation of cement products.

B. Do not direct vehicle or equipment exhaust toward protection zones, or discharge air borne dust, particulate matter, and air pollutants from construction activities.

C. Prohibit heat sources, flames, ignition sources, lighting of fires, and smoking within or near protection zones and organic mulch.

1.9 WARRANTY

A. Special Warranty: Contractor agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Death of tree, unsatisfactory growth, or permanent damage to tree health due to injury of roots, bark, trunk, branches, or foliage, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Employer.
b. Structural failures including plantings falling or blowing over due to destabilized or compromised root systems.
c. Faulty performance of excavation, root pruning, crown pruning, etc..
d. Deterioration or failure of any protective fencing during the specified maintenance period.

B. Warranty Period: Subject to contract terms and conditions with liability for the retained trees' health and survival not to exceed any formal Substantial Completion Certificate Date.

C. Any item installed or executed requiring maintenance even before the Substantial Completion Certificate is issued shall be part of the Contractor's obligation.

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PART 2 - PRODUCTS

2.1 MATERIALS

A. Backfill Soil: planting soil of suitable moisture holding capacity and granular texture for placing around tree; free of stones, roots, plants, sod, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous and deleterious materials harmful to plant growth.

1. Mixture: Well-blended mix of two parts stockpiled soil to one-part planting soil
2. Planting Soil: Planting soil as specified in project specifications or by Engineer.

B. Organic Mulch: Free from deleterious materials and suitable as a top dressing for trees and shrubs, consisting of one of the following:

1. Type: Shredded hardwood or Ground or shredded bark orr Wood and bark chips , as required by Engineer.
2. Size Range: 76 mm maximum, 13 mm minimum
3. Color: Natural.

C. Protection-Zone Fencing: Fencing fixed in position and meeting **one of** the following requirements:

1. Chain-Link Protection-Zone Fencing: Galvanized-steel or Polymer-coated steel or Polymer-coated galvanized-steel fencing fabricated from minimum 50-mm opening, 3.76-mm-diameter wire chain-link fabric; with pipe posts, minimum 60-mm-OD line posts, and 73-mm-OD corner and pull posts; with 42-mm-OD top rails ; with 4.5-mm-diameter top tension wire and 4.5-mm-diameter bottom tension wire; with tie wires, hog ring ties, and other accessories for a complete fence system.

   a. Height: 1800 mm
   b. Polymer-Coating Color: [Dark green] [Olive green] [Brown] [Black] <Insert color>.

2. Plywood Protection-Zone Fencing: Plywood framed with four 50-by-100-mm rails, with [100-by-100-mm] preservative-treated wood posts spaced not more than 2400 mm apart.

   a. Height: 1800 mm

   c. plywood and Lumber: Comply with requirements in specifications

3. Wood Protection-Zone Fencing: Constructed of two 50-by-100-mm horizontal rails, with 100-by-100-mm preservative-treated wood posts spaced not more than 2400 mm apart, and lower rail set halfway between top rail and ground.

   a. Height: 1200 mm
   b. Lumber: Comply with requirements in specifications.

4. Plastic Protection-Zone Fencing: Plastic construction fencing constructed of high-density extruded and stretched polyethylene fabric with 50-mm maximum opening in pattern and weighing a minimum of 0.6 kg/m; remaining flexible from minus 16 to plus 93 degree Celsius; inert to most chemicals and acids; minimum tensile yield strength of 13.8 MPa and ultimate tensile strength of 18.5 MPa; secured with plastic bands or galvanized-steel or stainless-steel wire ties; and supported by tubular or T-shape galvanized-steel posts spaced not more than 2400 mm apart.

   a. Height: 1200 mm
   b. Color: High-visibility orange, nonfading.

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5. Gates: Lockable Double swing access gates matching material and appearance of fencing, to allow for maintenance activities within protection zones; leaf width As indicated

D. Protection-Zone Signage: Shop-fabricated, rigid plastic or metal sheet with attachment holes pre-punched and reinforced; legibly printed with nonfading lettering and as follows:

1. Size and Text: As shown on Drawings
2. Lettering: 75-mm high minimum, white characters on colored background.
3. Language: If more than one language is required, include translated text and its placement.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Erosion and Sedimentation Control: Examine the site to verify that temporary erosion- and sedimentation-control measures are in place. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

B. Prepare written report, endorsed by arborist, listing conditions detrimental to tree and plant protection.

3.2 PREPARATION

A. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated or to be relocated. Tie a 25-mm blue vinyl tape around each tree trunk at 1372 mm above the ground.

B. Protect tree root systems from damage caused by runoff or spillage of noxious materials prior to and while mixing, placing, or storing construction materials. Protect root systems from ponding, eroding, or excessive wetting caused by dewatering operations.

3.3 TREE PROTECTION

A. Tree-Protection Zones: Mulch areas inside tree-protection zones and other areas indicated. Do not exceed indicated thickness of mulch.

1. Apply 100 mm uniform thickness of organic mulch unless otherwise indicated. Do not place mulch within 150 mm of tree trunks.
2. Install temporary root protection matting over mulch to the extent indicated.

B. Trunk Protection: Protect the trunk of each tree to remain as follows:

1. Install 50 x 150-mm wood planks around trunk at maximum 75 mm apart. Minimum three planks per tree. Band together with no less than three steel bands, stapled to the planks to hold them securely in place. Wrap orange plastic construction fencing to a minimum of three layers outside slats. Fasten wrap with wire.

   a. Height: 300 mm from lowest branch]

2. Wrap trunk with orange plastic construction fencing to 50 mm in thickness, minimum 6-mm closed-cell foam pads. Install 50 x 150-mm wood planks around trunk over wrap at maximum 75 mm apart. Minimum three planks per tree. Band together with no less than three steel bands, stapled to the planks to hold them securely in place.

   a. Height: (300 mm) from lowest branch

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3. Trunk protection to remain in place no longer than 12 months. If construction exceeds timeframe indicated, inspect trunk protection at 12-month intervals and loosen if necessary.

3.4 PROTECTION ZONES

A. Protection-Zone Fencing: Install protection-zone fencing along edges of protection zones before materials or equipment are brought on the site and construction operations begin in a manner that will prevent people and animals from easily entering protected areas except by entrance gates. Construct fencing so as not to obstruct safe passage or visibility at vehicle intersections where fencing is located adjacent to pedestrian walkways or in close proximity to street intersections, drives, or other vehicular circulation.

1. Chain-Link Fencing: Install to comply with ASTM F567 and with manufacturer's written instructions.
2. Posts: Set or drive posts into ground one-third the total height of the fence without concrete footings. Where a post is located on existing paving or concrete to remain, provide appropriate means of post support acceptable to Engineer.
3. Access Gates: Install where indicated, adjust to operate smoothly, easily, and quietly; free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
4. Plastic Fencing: Stretch fabric taut and secure to posts without bows or sags.

B. Protection-Zone Signage: Install protection-zone signage in visibly prominent locations in a manner approved by Engineer. Install one sign spaced approximately every 6 m on protection-zone fencing, but no fewer than four signs with each facing a different direction.

C. Maintain protection zones free of weeds and trash.

D. Maintain hydration of plants to assure plant survival.

E. Maintain protection-zone fencing and signage in good condition as acceptable to Engineer and remove when construction operations are complete and all tree/plantings threatening activities have ceased on site, including equipment removal.

1. Do not remove protection-zone fencing, even temporarily, to allow deliveries or equipment access through the protection zone.
2. Temporary access is permitted subject to preapproval in writing by arborist and Employer if a root buffer effective against soil compaction is constructed as directed by arborist. Maintain root buffer so long as access is permitted.

3.5 EXCAVATION

A. General: Excavate at edge of protection zones and for trenches indicated within protection zones in accordance with requirements in Division 31 Section 312000 "Earth Moving" unless otherwise indicated, and under the direction of project arborist.

1. Excavate only where absolute necessary.
2. Where possible, route utility trenches away from roots to avoid any damage.
3. Avoid excavation within the protection zone during hot, dry weather.

B. Trenching within Protection Zones: Where utility trenches are required within protection zones, excavate under or around tree roots by hand or with air spade, or tunnel under the roots by drilling, auger boring, or pipe jacking. Do not cut main lateral tree roots or taproots; cut only smaller roots that interfere with installation of utilities, with prior approval from certified arborist. Cut roots as

required for root pruning. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots.

C. Do not allow exposed roots to dry out before placing permanent backfill. Provide temporary earth cover or pack with peat moss and wrap with untreated burlap. Water and maintain in a moist condition. Temporarily support and protect roots from damage until they are permanently relocated and covered with soil.

3.6 ROOT PRUNING

A. Prune tree roots that are affected by temporary and permanent construction. Prune roots as shown on Drawings, under direction of Arborist and Site Engineer.

1. Cut roots manually by digging a trench and cutting exposed roots with sharp pruning instruments; do not break, tear, chop, or slant the cuts. Do not use a backhoe or other equipment that rips, tears, or pulls roots.
2. Cut Ends: Do not paint cut root ends
3. Temporarily support and protect roots from damage until they are permanently covered with soil.
4. Cover exposed roots with untreated burlap and water regularly to prevent drying out and maintain in a wet condition as long as necessary for temporary protection.
5. Backfill as soon as possible in accordance with requirements in Division 31 Section 312000 "Earth Moving."

B. Root Pruning at Edge of Protection Zone: Prune tree roots 300 mm outside and 300 mm inside of the protection zone by cleanly cutting all roots to the depth of the required excavation.

C. Root Pruning within Protection Zone: Clear and excavate by hand or with air spade to the depth of the required excavation to minimize damage to tree root systems. If excavating by hand, use narrow-tine spading forks to comb soil to expose roots. Cleanly cut roots as close to excavation as possible.

3.7 CROWN PRUNING

A. Prune branches affected by temporary and permanent construction. Prune branches under the direction of Arborist and Site Engineer.

1. Ascertain limbs to be trimmed with arborist. Clearly mark them to designate the approved points of cutting
2. Prune to remove only injured, broken, dying, or dead branches unless otherwise indicated. Do not prune for shape unless otherwise indicated.
3. Remove or reduce living branches to compensate for extensive root loss caused by damaging or cutting root system if needed as per arborist direction.
4. Pruning Standards: Prune trees in accordance with ANSI A300 (Part 1) and as indicated on Drawings.

    a. Type of Pruning: Cleaning, raising, reducing, and thinning where indicated.
    b. Specialty Pruning: Structural, restoration, vista, espalier, pollarding, palm and utility where indicated.

B. Unless otherwise directed by arborist and acceptable to Engineer, do not cut tree leaders.

C. Cut branches with sharp pruning instruments; do not break or chop.

D. Do not paint or apply sealants to wounds.

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E. Provide subsequent maintenance pruning during Contract period as recommended by arborist.

F. Chip removed branches and spread over areas identified by the Arborist and Site Engineer.

3.8 REGRADING

A. Lowering Grade: Where new finish grade is indicated below existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.

B. Lowering Grade within Protection Zone: Where new finish grade is indicated below existing grade around trees, slope grade away from trees as recommended by arborist unless otherwise indicated.

1. Root Pruning: Prune tree roots exposed by lowering the grade. Do not cut main lateral roots or taproots; cut only smaller roots. Cut roots as required for root pruning.

C. Raising Grade: Where new finish grade is indicated above existing grade around trees, slope grade beyond the protection zone. Maintain existing grades within the protection zone.

D. Minor Fill within Protection Zone: Where existing grade is 50 mm or less below elevation of finish grade, fill with backfill soil. Place backfill soil in a single uncompacted layer and hand grade to required finish elevations.

3.9 FIELD QUALITY CONTROL

A. Inspections: Engage a qualified arborist to direct plant-protection measures in the vicinity of trees, shrubs, and other vegetation indicated to remain and to prepare inspection reports.

3.10 REPAIR AND REPLACEMENT

A. General: Repair or replace trees, shrubs, and other vegetation indicated to remain or to be relocated that are damaged by construction operations, in a manner approved by Engineer.

1. Monitor and assess trees/plantings in decline or that have died, based on original report and any incident report(s).
2. Submit details of proposed pruning and repairs.
3. Perform repairs of damaged trunks, branches, and roots within 24 hours in accordance with arborist's written instructions.
4. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Engineer.

B. Trees: Remove and replace trees indicated to remain that are more than 20 percent dead or in an unhealthy or hazardous condition before the end of the corrections period or are damaged during construction operations that Engineer determines are incapable of restoring to normal growth pattern.

1. Small Trees: Provide new nursery-grown trees of same size and species as those being replaced for each tree that measures 100 mm or smaller in caliper size.
2. Large Trees: Provide two new nursery grown tree(s) of 150mm caliper size for each tree being replaced that measures more than 150 mm in caliper size.

    a. Species: As selected by the Arborist and Site Engineer.

3. Plant and maintain new trees as specified in Division 32 Section 329300 "Plants."

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3.11 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove excess excavated material, displaced trees, trash, and debris and legally dispose of them off Employer's property.

END OF SECTION 015639

SECTION 016000 - PRODUCT REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions and other Division 01 Specifications sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; Quality assurance, comparable products and Product substitutions.

B. If the requirements in this Section contradict with requirements in other Sections, the more stringent requirements shall prevail.

C. Related Requirements:

1. Division 01 Section 011000 "Summary" for Contractor requirements related to Employer-furnished products.
2. Division 01 Section 012500 "Substitution Procedures" for requests for substitutions.
3. Division 01, Section 014200 "References" for applicable industry standards for products specified.
4. Division 01, Section 017700 "Closeout Procedures" for submitting warranties.
5. Division 01, Section 018113.14 - Sustainable Design Requirements
6. Divisions 02 through 41, Specification Sections for specific requirements for warranties on products and installations specified to be warranted.

1.3 DEFINITIONS

A. Products: Items obtained for incorporating into the Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes the terms "material," "equipment," "system," and terms of similar intent.

1. New Products: Items that have not previously been incorporated into another project or facility. Salvaged items or items reused from other projects are not considered new products. Items that are manufactured or fabricated to include recycled content materials are considered new products, unless indicated otherwise.
2. Comparable Product: Product by named manufacturer that is demonstrated and approved through the comparable product submittal process described in Part 2, section 2.2 "Comparable Products", to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
3. Local Products: Naturally occurring materials found in the country that satisfy the required standards, products manufactured in the country from naturally occurring materials found in the country countries that satisfy the required standards, or products manufactured in the country that satisfy the required standards.
4. Other Products: All other products required for the Works that satisfy the required standards and which are excluded from the category of "Local Products".

B. Basis-of-Design Product Specification: A specification in which a single manufacturer's product is named and accompanied by the words "basis-of-design product," including make or model number or other designation. to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the Specification, published attributes and characteristics of basis-of-design product establish salient characteristics of products.

1. Evaluation of Comparable Products: In addition to the basis-of-design product description, product attributes and characteristics may be listed to establish the significant qualities related to type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other special features and requirements for purposes of evaluating comparable products of additional manufacturers named in the specification.

C. Subject to Compliance with Requirements: Where the phrase "Subject to compliance with requirements" introduces a product selection procedure in an individual Specification Section, provide products qualified under the specified product procedure. In the event that a named product or product by a named manufacturer does not meet the other requirements of the specifications, select another named product or product from another named manufacturer that does meet the requirements of the specifications; submit a comparable product request or substitution request, if applicable.

D. Comparable Product Request Submittal: An action submittal requesting consideration of a comparable product, including the following information:

1. Identification of basis-of-design product or fabrication or installation method to be replaced, including Specification Section number and title and Drawing numbers and titles.
2. Data indicating compliance with the requirements specified in Part 2 "Comparable Products" Article.

E. Basis-of-Design Product Specification Submittal: An action submittal complying with requirements in Section 013300 "Submittal Procedures".

F. Substitution: Refer to Section 012500 "Substitution Procedures" for definition and limitations on substitutions.

G. Manufacturer's Instructions and Manufacturer's Recommendations means latest published or printed version of 'manufacturer's written instructions' and 'manufacturer's written recommendations.

H. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for a particular product and specifically endorsed by manufacturer to Employer.

I. Special Warranty: Written warranty required by or incorporated into the Contract Documents, whether to extend time limit provided by manufacturer's warranty, or to provide for joint and several liability, or to provide more rights for Employer.

1.4 ACTION SUBMITTALS

A. Product List: Prepare and submit a list, in tabular form, identifying specified products. Include generic names of products required.

1. Coordinate product list with Contractor's Construction Program, the Submittals Schedule, and the Subcontract List.
2. Form: Tabulate information for each product under the following column headings:

a. Specification Section number and title.
b. Generic name used in the Contract Documents.
c. Specified warranty requirements, if any.
d. Model number, and similar designations.

e. Manufacturer's name and address.
f. Supplier's name and address.
g. Installer's name and address.
h. Total quantity required for the Works.
i. Projected delivery date or, if multiple deliveries, first and last delivery dates.
j. Identification of items that require early submittal approval for scheduled delivery date.

3. Initial Submittal: Within 14 days after Commencement Date, submit an electronic PDF copy and three (3) copies of initial product list. Include a written explanation for omissions of data and for variations from Contract requirements.

   a. At Contractor's option, initial submittal may be limited to product selections and designations that must be established early in Contract period.

4. Completed List: Within twenty-eight (28) days after Commencement Date, submit an electronic PDF copy and three (3) copies of completed product list. Include a written explanation for omissions of data and for variations from Contract requirements.
5. Engineer's Action: The Engineer will respond in writing to Contractor within 14 days of receipt of completed product list. The Engineer's response will include a list of unacceptable product selections and a brief explanation of reasons for this action. The Engineer's response, or lack of response, does not constitute a waiver of requirement that products comply with the Contract Documents.

B. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
2. Mark each copy of each submittal to show which products and options are applicable.
3. Include the following information, as applicable:

   a. Manufacturer's written recommendations.
   b. Manufacturer's product specifications.
   c. Manufacturer's installation instructions.
   d. Standard color charts.
   e. Manufacturer's catalog cuts.
   f. Wiring diagrams showing factory-installed wiring.
   g. Printed performance curves.
   h. Operational range diagrams.
   i. Mill reports.
   j. Standard product operation and maintenance manuals.
   k. Compliance with specified referenced standards.
   l. Testing by recognized testing agency.
   m. Application of testing agency labels and seals.
   n. Notation of coordination requirements.

4. Submit Product Data before or concurrent with Samples.

C. Compliance Statement: Submit a copy of project specifications identifying on each item whether or not the submission complies with that requirement.

D. Copy of Product Warranty.

E. The Engineer reserves the right to request further clarifications and particulars regarding any submission.

F. Substitution Requests: Refer to Section 012500 "Substitution Procedures".

G. Comparable Product Requests: Submit an Electronic copy and three (3) hard copies of each request for consideration of each comparable product. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.

1. Request Form: Use a form acceptable to the Engineer.
2. Documentation: Show compliance with requirements for approval of an unnamed product.
3. Engineer's Action: If necessary, the Engineer will request additional information or documentation for evaluation within one week of receipt of a request. The Engineer will notify the Contractor of acceptance or rejection of proposed comparable product within 28 days of receipt of request, or within 14 days of receipt of additional information or documentation, whichever is later.

    a. Form of Acceptance: Variation Order, without additional compensation.
    b. Use product specified if the Engineer cannot make a decision on use of a proposed comparable product within time allocated.

H. This specification is based on International **C**odes and standards. An accredited and approved laboratory / certification agency shall provide technical assessment regarding the suitability of products and tests made to other approved international standards to provide equal or better performance.

1. The technical assessment shall comprise a detailed technical comparison between the two standards.
2. The most stringent code shall prevail.
3. The Engineer, in all cases, has the right to evaluate such comparison and request from the contractor to abide by the specified standard.

I. Basis-of-Design Product Specification Submittal: Comply with requirements in Division 01 Section "Submittal Procedures." Show compliance with requirements.

J. Products Manufactured under license: Contractor submitting products in accordance with these specifications manufactured by a company other than the one specified and in another country shall submit also:

1. A letter from the original manufacturing company listed in the specifications certifying that the product submitted is manufactured under license and subject to quality control and supervision from the original manufacturing company.
2. Both the original manufacturing company and the subsidiary company shall have Quality Management System such as ISO 9001 and 9002.
3. The submitted product under license is equivalent to the original specified product in all respects.
4. The Engineer has the right to request further testing in an approved independent laboratory to demonstrate that the product manufactured under license is equivalent in all respects to the product manufactured by the original company.

K. LEED Submittals: Submit LEED requirements as stated in Division 01 and in other specification sections.

1.5 QUALITY ASSURANCE

A. Alternative Equivalent Standards: Product references to industry standards establish quantitative and qualitative attributes, characteristics and properties, required to be inherent in the specified product. Standard products not conforming to referenced standards, but otherwise exhibiting the same essential properties and conforming to another recognized equivalent industry standard may be used, subject to approval and compliance with other specified requirements.

1. Recognized standards are those which are listed in Division 01 Section "References".

2. Comply with provisions in "Comparable Products" Article to obtain approval for use of a product conforming with an alternative equivalent standard.

B. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

1. Resolution of Compatibility Disputes between Multiple Contractors:

a. Each Contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
b. If a dispute arises between the multiple contractors over concurrently selectable but incompatible products, the Engineer will determine which products shall be used.

C. Identification of Products: Except for required labels and operating data, do not attach or imprint manufacturer or product names or trademarks on exposed surfaces of products or equipment that will be exposed to view in occupied spaces or on the exterior.

1. Labels: Locate required product labels and stamps on a concealed surface, or, where required for observation following installation, on a visually accessible surface that is not conspicuous.
2. Equipment Nameplates: Provide a permanent nameplate on each item of service or power operated equipment. Locate on a visually accessible but inconspicuous surface. Include information essential for operation, including the following:

a. Name of product.
b. Model and serial number.
c. Capacity.
d. Speed.
e. Ratings.

3. See individual identification Sections in Divisions 21, 22, 23, and 26 for additional equipment identification requirements.

D. Source Limitations: To the fullest extent possible, provide products of the same type and kind from a single source.

1. If a specified product is available only from a source that cannot produce or supply sufficient quantities to execute and/or complete Project requirements in a timely manner, request the Engineer to determine the most essential qualities, attributes and characteristics required in the specified product, in order to select a comparable product possessing the same relevant, significant properties.
2. Comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.

E. Compliance with Contract Documents: Contractor shall fully and unconditionally comply with requirements set in the Contract Documents.

F. Manufacturers'/ Installers' Qualifications: submit manufacturer / supplier profile form.

1.6 COORDINATION

A. Modify or adjust affected work as necessary to integrate work of approved comparable products and approved substitutions.

1.7 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products, using means and methods that will prevent damage, deterioration, and loss, including theft and vandalism. Comply with manufacturer's written instructions.

B. Delivery and Handling:

1. Schedule delivery to minimize long-term storage at Project site and to prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to determine compliance with the Contract Documents and that products are undamaged and properly protected.

C. Storage:

1. Store products to allow for inspection and measurement of quantity or counting of units.
2. Store materials in a manner that will not endanger Project structure.
3. Store products that are subject to damage by the elements under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation and with adequate protection from wind.
4. Protect foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
5. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
6. Protect stored products from damage and liquids from freezing.
7. Provide a secure location and enclosure at Project site for storage of materials and equipment.
8. Utilize the secure location and enclosure at Project site for storage of materials and equipment provided by the Employer.

1.8 PRODUCT WARRANTIES

A. Warranties specified in other Sections and other Contract Documents shall be in addition to, and run concurrent with the below general warranty requirements. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.

1. Manufacturer's Warranty: Written standard warranty form furnished by individual manufacturer for a particular product and issued in the name of the Employer and the Contractor or endorsed by manufacturer to Employer.
2. Special Warranty: Written warranty required by the Contract Documents to provide specific rights for Employer and issued in the name of the Employer and the Contractor or endorsed by manufacturer to Employer.
3. All costs of repairing any defects in the Works due to this defect shall be borne by the warrantors.
4. Refer to Divisions 02 through 41, Technical Specification Sections for specific content requirements and particular requirements for submitting special warranties.
5. Submit form of warranty for the Engineer’s approval.

B. Special Warranties: Prepare a written document that contains appropriate terms and identification, ready for execution.

1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.

2. Specified Form: When specified forms are included in the Project Manual, prepare a written document, using indicated form properly executed.
3. See other Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time: Comply with requirements in Section 017700 "Closeout Procedures."

D. Warranty Requirements:

1. Related Damages and Losses: When correcting failed or damaged warranted construction, remove and replace construction that has been damaged as a result of such failure or must be removed and replaced to provide access for correction of warranted construction.
2. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty period with an equitable adjustment for depreciation.
3. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of the Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Employer has benefited from use of the Work through a portion of its anticipated useful service life.
4. Employer's Recourse: Expressed warranties made to the Employer are in addition to implied warranties and shall not limit the duties, obligations, rights, and remedies otherwise available under the law. Expressed warranty periods shall not be interpreted as limitations on the time in which the Employer can enforce such other duties, obligations, rights, or remedies.

E. Rejection of Warranties: The Employer reserves the right to reject warranties and to limit selection to products with warranties not in conflict with requirements of the Contract Documents.

F. Where the Contract Documents require a special warranty, or similar commitment on the Work or part of the Work, the Employer reserves the right to refuse to accept the Work, until the Contractor presents evidence that entities required to countersign such commitments are willing to do so.

G. Manufacturer Warranties and Special Warranties: Prepare a written document, ready for execution, that contains appropriate terms and conditions, and identifies commencement date and warranty period, submit a draft and obtain the Engineer's written approval before final execution.

1. Manufacturer's Standard Form: Modified to include Project-specific requirements and information, and properly executed; or
2. Special Form: Individually prepared and specially drafted to include Project-specific requirements and information, and properly executed.
3. Refer to Divisions 2 through 41 Sections for specific content requirements and particular requirements for submitting special warranties.

H. Submittal of Warranties: Comply with requirements in Division 01 Section 017700 "Closeout Procedures."

PART 2 - PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Locally manufactured or imported products, materials, and equipment shall satisfy the below requirements.

B. Local Regulations and Codes: Comply with applicable requirements of the local codes and regulations of authorities having jurisdiction.

1. Obtain necessary approvals from authorities having jurisdiction.
2. Verify applicable performances whenever relevant equivalent counterparts to applicable standards are substituted and submit a comprehensive comparative matrix of equivalency between specified standard and proposed counterpart for Engineer’s approval.

C. General Product Requirements: Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Employer reserves the right to limit selection to products with warranties meeting requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," the Engineer will make selection.
5. Where products are accompanied by the term "match sample," sample to be matched is Engineer's.
6. Descriptive, performance, and reference standard requirements in the Specifications establish salient characteristics of products.
7. Or Approved Equal: For products specified by name and accompanied by the term "or equal," "or approved equal," or "or approved," comply with requirements in "Comparable Products" Article to obtain approval for use of an unnamed product.

    a. Submit additional documentation required by the Engineer through Construction Manager in order to establish equivalency of proposed products. Unless otherwise indicated, evaluation of "or equal" product status is by the Engineer, whose determination is final.
    b. The Engineer reserves the right to limit selection to named products specified.
    c. Unless otherwise agreed, contract unit rates and prices will be deemed to be based on the use of named products specified in the Contract Documents.

D. Product Selection Procedures:

1. Sole Product: Where Specifications name a single manufacturer and product, provide the named product that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.

    a. Sole product may be indicated by the phrase "Subject to compliance with requirements, provide the following."

2. Sole Manufacturer / Source: Where Specifications name a single manufacturer or source, provide a product by the named manufacturer or source that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered.

    a. Sole manufacturer / source may be indicated by the phrase "Subject to compliance with requirements, provide products by the following."

3. Limited List of Products: Where Specifications include a list of products, the products should fully comply with requirements.

    a. Limited list of products may be indicated by the phrase "Subject to compliance with requirements, provide one of the following".

4. Non-Limited List of Products: Where Specifications include a list of products, the products should be fully complied with requirements. Comply with requirements in "Comparable Products" Article for consideration of an unnamed product.

a. Non-limited list of products is indicated by the phrase "Subject to compliance with requirements, available products that may be incorporated in the Work include, but are not limited to, the following."
b. Provision of an unnamed product is not considered a substitution, if the product complies with requirements.

5. Limited List of Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements. Comparable products or substitutions for Contractor's convenience will not be considered unless otherwise indicated.

    a. Limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, provide products by one of the following".

6. Non-Limited List of Manufacturers: Where Specifications include a list of available manufacturers, provide a product by one of the manufacturers listed or a product by an unnamed manufacturer that complies with requirements.

    a. Non-limited list of manufacturers is indicated by the phrase "Subject to compliance with requirements, available manufacturers whose products may be incorporated in the Work include, but are not limited to, the following".

7. Available Products: Where Specification paragraphs or subparagraphs titled "Available Products", provide the products that complies with requirements. Comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.
8. Product Options: Where Specification paragraphs titled "Product Options" indicate that size, profiles, and dimensional requirements on Drawings are based on a specific product or system, provide either the specific product or system indicated or a comparable product or system by another manufacturer. Comply with provisions in "Comparable Products" Article to obtain approval for use of product.
9. Basis-of-Design Product: Where Specifications name a product, or refer to a product indicated on Drawings, provide the specified or indicated product or a comparable product by one of the other named manufacturers. Drawings and Specifications may additionally indicate sizes, profiles, dimensions, and other characteristics that are based on the product named. Comply with requirements in "Comparable Products" Article for consideration.

    a. For approval of products, comply with requirements in Section 012500 "Substitution Procedures" for substitutions for convenience.

E. Visual Matching Specification: Where Specifications require the phrase "match the Engineer's sample," provide a product that complies with requirements and matches the Engineer's sample. The Engineer's decision will be final on whether a proposed product match.

1. If no product available within specified category matches and complies with other specified requirements, comply with requirements in Section 012500 "Substitution Procedures" for proposal of product.

F. Visual Selection Specification: Where Specifications include the phrase "as selected by the Engineer from manufacturer's full range" or a similar phrase, select a product that complies with requirements. The Engineer will select color, gloss, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

a. Standard Range: Where Specifications include the phrase "standard range of colors, patterns, textures" or similar phrase, the Engineer will select color, pattern, density, or texture from manufacturer's product line that does not include premium items.
b. Full Range: Where Specifications include the phrase "full range of colors, patterns, textures" or similar phrase, the Engineer will select color, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

G. Sustainable Product Selection: Where Specifications require product to meet sustainable product characteristics, select products complying with indicated requirements. Comply with requirements in Division 01 “Sustainable Design Requirements –Specification Sections.

1. Select products for which sustainable design documentation submittals are available from manufacturer.

2.2 COMPARABLE PRODUCTS

A. Conditions for Consideration of Comparable Products: the Engineer will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, the Engineer may return requests without action, except to record noncompliance with the following requirements:

1. Evidence that proposed product does not require revisions to the Contract Documents, is consistent with the Contract Documents, will produce the indicated results, and is compatible with other portions of the Work.
2. Detailed comparison of significant qualities of proposed product with those of the named basis-of-design product. Significant product qualities include attributes, such as type, function, in-service performance and physical properties, weight, dimension, durability, visual characteristics, and other specific features and requirements.
3. Evidence that proposed product provides specified warranty.
4. List of similar installations for completed projects, with project names and addresses and names and addresses of the Engineers and Employers, if requested.
5. Samples, if requested.

B. Engineer's Action on Comparable Products Submittal: If necessary, the Engineer will request additional information or documentation for evaluation, as specified in Section 013300 "Submittal Procedures."

1. Form of Approval of Submittal: As specified in Section 013300 "Submittal Procedures."
2. Use product specified if the Engineer does not issue a decision on use of a comparable product request within time allocated.

C. Submittal Requirements, Two-Step Process: Approval by the Engineer of Contractor's request for use of comparable product is not intended to satisfy other submittal requirements. Comply with specified submittal requirements.

D. Submittal Requirements, Single-Step Process: When acceptable to Engineer, incorporate specified submittal requirements of individual Specification Section in combined submittal for comparable products. Approval by the Engineer of Contractor's request for use of comparable product and of individual submittal requirements will also satisfy other submittal requirements.

PART 3 - EXECUTION (Not Used)

END OF SECTION 016000

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SECTION 017300 - EXECUTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions and other Division 01 Specifications sections, apply to this Section.

1.2 SUMMARY

A. Section includes general administrative and procedural requirements governing execution of the Work, including, but not limited to, the following:

1. Construction layout.
2. Field engineering and surveying.
3. Installation of the Work.
4. Cutting and patching.
5. Coordination of Employer's portion of the Work.
6. Progress cleaning.
7. Starting and adjusting.
8. Protection of installed construction.
9. Correction of the Work.

B. Related Requirements:

1. Division 01, Section 011000 "Summary" for coordination of Employer-performed work and limits on use of Project site.
2. Division 01 Section 013300 "Submittal Procedures" for submitting surveys.
3. Division 01, Section 017700 "Closeout Procedures" for submitting final property survey with Project Record Documents, recording of Employer-accepted deviations from indicated lines and levels, replacing defective work, and final cleaning.
4. Division 02, Section 024119 "Selective Demolition" for demolition and removal of selected portions of the building.
5. Division 07, Section 078413 "Penetration Firestopping" for patching penetrations in fire-rated construction.
6. Specification sections related to the functionality and efficiency of the executed systems.

1.3 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of subsequent work.

B. Patching: Fitting and repair work required to restore construction to original conditions after installation of subsequent work.

1.4 PREINSTALLATION MEETINGS

A. Cutting and Patching Conference: Conduct conference at Project site.

1. Prior to submitting cutting and patching plan, review extent of cutting and patching anticipated and examine procedures for ensuring satisfactory result from cutting and patching

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work. Inform Engineer of scheduled meeting. Require representatives of each entity directly concerned with cutting and patching to attend, including the following:

a. Contractor's superintendent.
b. Trade supervisor responsible for cutting operations.
c. Trade supervisor(s) responsible for patching of each type of substrate.
d. Mechanical, electrical, and utilities subcontractors' supervisors, to the extent each trade is affected by cutting and patching operations.

2. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

B. Layout Conference: Conduct conference at Project site.

1. Prior to establishing layout of new perimeter and structural column grid(s), review building location requirements. Review benchmark, control point, and layout and dimension requirements. Inform Engineer of scheduled meeting. Require representatives of each entity directly concerned with Project layout to attend, including the following:

a. Contractor's superintendent.
b. Professional surveyor(s) responsible for performing Project surveying and layout.
c. Professional surveyor(s) responsible for performing site survey serving as basis for Project design.

2. Review meanings and intent of dimensions, notes, terms, graphic symbols, and other layout information indicated on the Drawings.
3. Review requirements for including layouts on Shop Drawings and other submittals.
4. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For land surveyor(s)

B. Certified Surveys: Submit two (2) copies signed by land surveyor(s)

C. Certificates: Submit certificate signed by land surveyor(s), certifying that location and elevation of improvements comply with requirements.

D. Cutting and Patching Plan: Submit plan describing procedures at least ten (10) days prior to the time cutting and patching will be performed. Include the following information:

1. Extent: Describe reason for and extent of each occurrence of cutting and patching.
2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.
3. Products: List products to be used for patching and firms or entities that will perform patching work.
4. Dates: Indicate when cutting and patching will be performed.
5. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.

a. Include description of provisions for temporary services and systems during interruption of permanent services and systems.

E. Landfill Receipts: Submit copy of receipts issued by a landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.

F. Method Statement: Submit method statement to be used for construction layout.

1.6 CLOSEOUT SUBMITTALS

A. Final Property Survey: Submit ten (10) copies showing the Work performed and record survey data.

1.7 QUALITY ASSURANCE

A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.

B. Professional Engineer Qualifications: Refer to Section 014000 "Quality Requirements."

C. Cutting and Patching: Comply with requirements for and limitations on cutting and patching of construction elements.

1. Structural Elements: When cutting and patching structural elements, or when encountering the need for cutting and patching of elements whose structural function is not known, notify Engineer of locations and details of cutting and await directions from Engineer before proceeding. Shore, brace, and support structural elements during cutting and patching. Do not cut and patch structural elements in a manner that could change their load-carrying capacity or increase deflection.
2. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.

3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.

4. Visual Elements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch exposed construction in a manner that would, in Engineer's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

D. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of specified products and equipment.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Comply with requirements specified in other Sections.

1. For projects requiring compliance with sustainable design and construction practices and procedures, use products for patching that comply with sustainable design requirements.

B. In-Place Materials: Use materials for patching identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.

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1. If identical materials are unavailable or cannot be used, use materials that, when installed, will provide a match acceptable to Engineer for the visual and functional performance of in-place materials. Use materials that are not considered hazardous.

C. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.

1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, gas service piping, and water-service piping; underground electrical services; and other utilities.
2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
3. Furnish a BIM model ready for integration with Digital Twin Platform representation of existing condition utilizing Reality Capture technologies, processes and procedures. The BIM model to be verified by the Engineer.

B. Examination and Acceptance of Conditions: Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.

C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:

1. Description of the Work, including Specification Section number and paragraph, and Drawing sheet number and detail, where applicable.
2. List of detrimental conditions, including substrates.
3. List of unacceptable installation tolerances.
4. Recommended corrections.

D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

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3.2 PREPARATION

A. Existing Utility Information: Furnish information to Employer that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.

B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.

D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Engineer in accordance with requirements in Section 013100 "Project Management and Coordination."

E. Existing Utility Interruptions: Do not interrupt utilities serving facilities occupied by the Employer or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify the Engineer rand Employer not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without the Engineer's written permission

3.3 SETTING OUT AND ACCURACY

A. Site Survey: Before commencing work on Site, the Contractor shall carry out a topographical survey of the Site, in conjunction with, or as instructed by, the Engineer's Representative, or of such parts of the Site as the Engineer's Representative may direct, to record the site limits, dimensions, ground levels, obstructions and other features and to establish base lines and points for future setting out and to record the basis for re-measurement of excavation and earthwork, where applicable.

The site survey shall be carried out utilizing Reality Capture technologies, processes and procedures, and be coordinated as a Scan–to–BIM model driven Site Survey.

B. Setting Out: Details of methods and equipment to be used in setting out the Works shall be submitted to the Engineer. The Contractor shall inform the Engineer when setting out is complete and, before commencing construction, shall provide point layout BIM model ready for integration with Digital Twin Platform and instruments and assistance for the Engineer to check the setting out if required by the Engineer.

C. Infrastructure and Utility Work: Setting out shall be as shown on the Drawings extracted from the point layout BIM model or as instructed by the Engineer. It shall be revised if, in the opinion of the Engineer, modification of grade and line is advisable.

D. Record Drawings: The Contractor shall record details of all grid lines, existing ground levels, setting-out stations, benchmarks and profiles, Site BIM Model and the extracted site setting-out drawing; retain on the Site throughout the duration of the Contract and hand to the Engineer's Representative on completion.

E. Dimensions and levels both on the Drawings extracted from the point layout BIM model and the Site, shall be checked, particularly the correlation between components and the work in place. Materials and components shall not be ordered or work carried out until any discrepancies have been resolved with the Engineer.

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F. Tolerances: Infrastructure and utility work shall be within tolerances stated in the Specification or as instructed.

G. Non-Compliance: Work which fails to meet the specified levels of accuracy must not be rectified without approval. Submit proposals for such rectification or removal and replacement and meet all costs arising, including effects on other work.

3.4 CONSTRUCTION LAYOUT

A. Method Statement: Before verifying layout, information shown on Drawings, prepare a detailed method statement comprising a descriptive narrative and drawings, clearly describing and identifying means and methods to be used for construction layout including but not limited to:

1. Establishing benchmarks and control points to set lines and levels at each storey of construction and elsewhere as needed to locate each element of the Works.
2. Locating offsets for gridlines.
3. Locating and sizing penetrations in structures as needed to transfer lines and levels horizontally and vertically.

B. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks and existing conditions. If discrepancies are discovered, notify Engineer and Construction Manager promptly.

C. Engage a land surveyor experienced in laying out the Work, using the following accepted surveying practices:

1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of Project.
2. Establish limits on use of Project site.
3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
4. Inform installers of lines and levels to which they must comply.
5. Check the location, level and plumb, of every major element as the Work progresses.
6. Notify Engineer when deviations from required lines and levels exceed allowable tolerances.
7. Close site surveys with an error of closure equal to or less than the standard established by authorities having jurisdiction.

D. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and rim and invert elevations.

E. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.

F. Record Log: Maintain a log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by Engineer.

1. Advise the Engineer when deviations, exceeding indicated or recognized tolerances, are detected.
2. Record deviations that are accepted and not corrected on Record (As-Built) Drawings.

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G. Auxiliary Services: Cooperate with the Engineer and provide, when requested, auxiliary services to enable and assist the Engineer to check the Contractor's site survey, layout and control work, including means of access to Site, use of instruments and tapes, and supply of survey

3.5 FIELD ENGINEERING

A. Identification: Employer will identify existing benchmarks, control points, and property corners.

B. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.

1. Do not change or relocate existing benchmarks or control points without prior written approval of Engineer. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to Engineer before proceeding.
2. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.

C. Benchmarks: Establish and maintain a minimum of two (2) permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.

1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
2. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
3. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.

D. Certified Survey: On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.

E. Final Property Survey: Engage a land surveyor(s) to prepare a final property survey showing significant features (real property) for Project. Include on the survey a certification, signed by land surveyor(s) that principal metes, bounds, lines, and levels of Project are accurately positioned as shown on the survey.

1. Show boundary lines, monuments, streets, site improvements and utilities, existing improvements and significant vegetation, adjoining properties, acreage, grade contours, and the distance and bearing from a site corner to a legal point.
2. Recording: At Substantial completion have the final property survey recorded by or with authorities having jurisdiction as the official "property survey."

3.6 INSTALLATION

A. Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.

1. Make vertical work plumb and make horizontal work level.
2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
4. Maintain minimum headroom clearance of 2440 mm in occupied spaces and 2300 mm in unoccupied spaces, unless otherwise indicated on Drawings.

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B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at the time and under conditions that will ensure satisfactory results as judged by Engineer. Maintain conditions required for product performance until Substantial completion.

D. Conduct construction operations, so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy of type expected for Project.

E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on-site and placement in permanent locations.

F. Tools and Equipment: Select tools or equipment that minimize production of excessive noise levels.

G. Templates: Obtain and distribute to the parties involved templates for Work specified to be factory prepared and field installed. Check Shop Drawings of other portions of the Work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.

H. Attachment: Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions with manufacturer.

1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Engineer.
2. Allow for building movement, including thermal expansion and contraction.
3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

I. Joints: Make joints of uniform width. Where joint locations in exposed Work are not indicated, arrange joints for the best visual effect, as judged by Engineer. Fit exposed connections together to form hairline joints.

J. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

3.7 CUTTING AND PATCHING

A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

B. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.

C. Temporary Support: Provide temporary support of Work to be cut.

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D. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

E. Adjacent Occupied Areas: Where interference with use of adjoining areas or interruption of free passage to adjoining areas is unavoidable, coordinate cutting and patching in accordance with requirements in Section 011000 "Summary."

F. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.

G. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots neatly to minimum size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
4. Excavating and Backfilling: Comply with requirements in applicable Sections where required by cutting and patching operations.
5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
6. Proceed with patching after construction operations requiring cutting are complete.

H. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as practicable, as judged by Engineer. Provide materials and comply with installation requirements specified in other Sections, where applicable.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate physical integrity of installation.
2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.

    a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
    b. Restore damaged pipe covering to its original condition.

3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

    a. Where patching occurs in a painted surface, prepare substrate and apply primer and intermediate paint coats appropriate for substrate over the patch, and apply final paint coat over entire unbroken surface containing the patch, corner to corner of wall and edge to edge of ceiling. Provide additional coats until patch blends with adjacent surfaces.

4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.

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5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition and ensures thermal and moisture integrity of building enclosure.

I. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

3.8 COORDINATION OF EMPLOYER'S PORTION OF THE WORK

A. Site Access: Provide access to Project site for Employer's construction personnel and Employer's separate contractors.

1. Provide temporary facilities required for Employer-furnished, Contractor-installed and Employer-furnished, Employer-installed products.
2. Refer to Section 011000 "Summary" for other requirements for Employer-furnished, Contractor-installed and Employer-furnished, Employer-installed] products.

B. Coordination: Coordinate construction and operations of the Work with work performed by Employer's construction personnel and Employer's separate contractors.

1. Construction Schedule: Inform Employer of Contractor's preferred construction schedule for Employer's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify Employer if changes to schedule are required due to differences in actual construction progress.
2. Preinstallation Conferences: Include Employer's construction personnel and Employer's separate contractors at preinstallation conferences covering portions of the Work that are to receive Employer's work. Attend preinstallation conferences conducted by Employer's construction personnel if portions of the Work depend on Employer's construction.

3.9 PROGRESS CLEANING

A. Clean Project site and work areas daily, including common areas. Enforce requirements strictly. Dispose of materials lawfully.

1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
2. Do not hold waste materials more than seven days during normal weather or three days if the temperature is expected to rise above 27 deg C.
3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.

    a. Use containers intended for holding waste materials of type to be stored.

4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.

B. Site: Maintain Project site free of waste materials and debris.

C. Work Areas: Clean areas where Work is in progress to the level of cleanliness necessary for proper execution of the Work.

1. Remove liquid spills promptly.
2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.

D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically

recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.

E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

F. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial completion.

G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 015000 "Temporary Facilities and Controls." And Section 017419 "Construction Waste Management and Disposal."

H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial completion.

I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
Such exposures include, but are not limited to, the following:

1. Excessive static or dynamic loading.
2. Excessive internal or external pressures.
3. Excessively high or low temperatures.
4. Thermal shock.
5. Excessively high or low humidity.
6. Pollution and air contamination.
7. Water.
8. Chemicals and solvents.
9. Light.
10. Radiation.
11. Puncture.
12. Abrasion.
13. Heavy traffic.
14. Soiling, staining, and corrosion.
15. Bacteria.
16. Rodent and insect infestation.
17. Combustion.
18. Electrical current.
19. High-speed operation.
20. Improper lubrication.
21. Unusual wear or other misuse.
22. Contact between incompatible materials.
23. Destructive testing.
24. Misalignment.
25. Excessive weathering.
26. Unprotected storage.
27. Improper shipping or handling.
28. Theft or vandalism.

J. Limiting Exposures: Supervise construction operations to ensure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

K. Cutting and Patching: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

1. Thoroughly clean piping, conduit, and similar features before applying paint or other finishing materials. Restore damaged pipe covering to its original condition.

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3.10 STARTING AND ADJUSTING

A. Coordinate startup and adjusting of equipment and operating components with requirements in Section 019113 "General Commissioning Requirements."

B. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

C. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.

D. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

E. Manufacturer's Field Service: Comply with qualification requirements in Section 014000 "Quality Requirements."

3.11 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial completion.

B. Protection of Existing Items: Provide protection and ensure that existing items to remain undisturbed by construction are maintained in condition that existed at commencement of the Work.

C. Comply with manufacturer's written instructions for temperature and relative humidity.

3.12 CORRECTION OF THE WORK

A. Repair or remove and replace damaged, defective, or nonconforming Work. Restore damaged substrates and finishes.

1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.

B. Repair Work previously completed and subsequently damaged during construction period. Repair to like-new condition.

C. Restore permanent facilities used during construction to their specified condition.

D. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.

E. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.

F. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION 017300

SECTION 017312 - CUTTING AND PATCHING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes procedural requirements for cutting and patching.

B. Related Sections include the following:

1. Section 016000 "Product Requirements" for requirements regarding submittals and substitutions of products.
2. Division 01 Section related to sustainability requirements, as applicable.
3. Division 01 Section "Selective Structure Demolition" for demolition of selected portions of the building.
4. Divisions 02 through 34 Sections for specific requirements and limitations applicable to cutting and patching individual parts of the Work.

1.3 DEFINITIONS

A. Cutting: Removal of in-place construction necessary to permit installation or performance of other Work.

B. Patching: Fitting and repair work required to restore surfaces to original conditions after installation of other Work.

1.4 SUBMITTALS

A. Cutting and Patching Proposal: Submit a proposal describing procedures at least 10 days before the time cutting and patching will be performed, requesting approval to proceed. Include the following information:

1. Extent: Describe cutting and patching, show how they will be performed, and indicate why they cannot be avoided.
2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
3. Survey of concerned areas, to Engineer's satisfaction:

    a. Survey report and drawings of existing conditions correlated with requirements indicated for cutting and patching.

4. Products: List products to be used and firms or entities that will perform the Work.
5. Dates: Indicate when cutting and patching will be performed.
6. Utility Services and Mechanical/Electrical Systems: List services/systems that cutting and patching procedures will disturb or affect. List services/systems that will be relocated and

those that will be temporarily out of service. Indicate how long services/systems will be disrupted.

7. Structural Elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure.
8. Engineer's Approval: Obtain approval of cutting and patching proposal before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work.

1.5 QUALITY ASSURANCE

A. Sustainability Requirements for Building Reuse:

1. All related Product Data as detailed in Division 01 Sections related to sustainability requirements, as applicable.

B. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.

C. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.

D. Miscellaneous Elements: Do not cut and patch miscellaneous elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.

E. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on the exterior or in occupied spaces in a manner that would, in Engineer's opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

F. Cutting and Patching Conference: Before proceeding, meet at Project site with parties involved in cutting and patching, including mechanical and electrical trades. Review areas of potential interference and conflict. Coordinate procedures and resolve potential conflicts before proceeding.

1.6 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, by methods and with materials so as not to void existing warranties.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Comply with requirements specified in other Sections.

B. In-Place Materials: Use materials identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible. If identical materials are unavailable or cannot be used, use materials that, when installed, will match the visual and functional performance of in-place materials.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.

1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with in-place finishes or primers.
2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Temporary Support: Provide temporary support of Work to be cut.

B. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

D. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to prevent interruption to occupied areas.

3.3 PERFORMANCE

A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at the earliest feasible time, and complete without delay.

1. Cut in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.

B. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer; comply with original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. Finished Surfaces: Cut or drill from the exposed or finished side into concealed surfaces.
3. Concrete and Masonry: Cut using a cutting machine, such as an abrasive saw or a diamond-core drill.
4. Excavating and Backfilling: Comply with requirements in applicable Division 02 Sections where required by cutting and patching operations.
5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. Cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
6. Proceed with patching after construction operations requiring cutting are complete.

C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.

    a. Clean piping, conduit, and similar features before applying paint or other finishing materials.
    b. Restore damaged pipe covering to its original condition.

3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

    a. Where patching occurs in a painted surface, apply primer and intermediate paint coats over the patch and apply final paint coat over entire unbroken surface containing the patch. Provide additional coats until patch blends with adjacent surfaces.

4. Ceilings: Patch, repair, or rehang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weathertight condition.

D. Cleaning: Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, and similar materials.

END OF SECTION 017312

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SECTION 017419 - CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions and other Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for the following:

1. Salvaging nonhazardous demolition and construction waste.
2. Recycling nonhazardous demolition and construction waste.
3. Disposing of nonhazardous demolition and construction waste.

B. Related Requirements:

1. Division 01 Section 01200 "Multiple Contract Summary" for coordination of responsibilities for waste management.
2. Division 01 Section 018113.14 "Sustainable Design Requirements" for Sustainability requirements.
3. All relevant sections under Division 04 till Division 31.

1.3 DEFINITIONS

A. Construction Waste: Building, structure, and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.

B. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.

C. Disposal: Removal of demolition or construction waste and subsequent salvage, sale, recycling, or deposit in landfill, incinerator acceptable to authorities having jurisdiction, or designated spoil areas on Employer’s property.

D. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

E. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.

F. Salvage and Reuse: Recovery of demolition or construction waste and subsequent incorporation into the Works.

G. Alternative Daily Cover (ADC): Material other than earthen material placed on the surface of the active face of a municipal solid waste landfill at the end of each operating day to control vectors, fires, odors, blowing litter and scavenging.

H. Commingled Waste: Building waste streams that are combined on the project site and hauled away for sorting into recyclable streams. Also known as single-stream recycling.

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I. Environmental Consultant: Environmental Consultant appointed by the Employer for auditing and monitoring the Contractor's compliance with this Section of the Specification.

J. Land clearing debris: materials that are natural (e.g. rock, soil, stone, vegetation). Materials that are man-made (e.g., concrete, brick, cement, steel) are considered construction waste even if they were on site.

K. Waste Diversion: A management activity that disposes of waste through methods other than incineration or landfilling. Examples include reuse and recycling.

1.4 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition and construction waste becomes the property of Contractor.

B. Historic items, relics, antiques, and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to Employer that may be uncovered during demolition remain the property of Employer.

1. Carefully salvage in a manner to prevent damage and promptly return to Employer.

1.5 CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT PLANNING

A. Develop and implement a construction and demolition waste management plan:

1. Establish waste diversion goals for the project by identifying at least five materials (both structural and nonstructural) targeted for diversion. Approximate a percentage of the overall project waste that these materials represent.
2. Specify that materials will be separated and describe the diversion strategies planned for the project. Describe where the material will be taken and how the recycling facility will process the material.

B. Provide a final report detailing all major waste streams generated, including disposal and diversion rates.

C. Alternative daily cover (ADC) does not qualify as material diverted from disposal. Land clearing debris is not considered construction, demolition, or renovation waste that can contribute to waste diversion.

1.6 CONSTRUCTION AND DEMOLITION WASTE MANAGEMENT

A. Recycle and/or salvage nonhazardous construction and demolition materials. Calculations shall be by weight.

B. Divert 75% and Four Material Streams. Divert at least 75% of the total construction and demolition material; diverted materials must include at least four material streams. Streams to be diverted shall be agreed with the Engineer. A material stream should constitute at least 5% by weight of total diverted materials. Exclude hazardous waste, land-clearing debris, soil, and landscaping materials from calculations

C. Reduction of Total Waste Material: Do not generate more than 2.5 pounds of construction waste per square foot (12.2 kilograms of waste per square meter) of the building's floor area. Exclude on-site reused materials. Materials reused on site are not considered waste for the purposes of calculating option D only.

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D. Contractor shall choose one item only from C and D above; however, this shall be agreed with the Engineer before the start of the work.

E. Concrete waste if any must be diverted to Construction Waste Treatment Plant.

F. Other recyclable materials such as woods, plastics and metals can be re-used at site.

G. Excavated soil, land-clearing debris and hazardous waste must be diverted to places designated by the concerned department (these materials are exempt while calculating the percentages for recycling or reuse).

1.7 PERFORMANCE REQUIREMENTS

A. Contractor to achieve end-of-Project rates for salvage/recycling of 75 percent by weight of total non-hazardous solid waste generated by the works. Diverted materials must include at least four material streams, or do not generate more than 12.2 kilograms of waste per square meter of the building's floor area. Practice efficient waste management in the use of materials in the course of the Works. Use all reasonable means to divert construction and demolition waste from landfills and incinerators.

B. Contractor and his sub-contractors shall be audited and/or required to provide information at any time during the construction phase by the Engineer or by the Environmental Consultant.

C. Contractor and his sub-contractors shall provide Sustainability progress report at any time requested by the Engineer but not less than monthly to confirm compliance with Sustainability requirements.

D. Facilitate recycling and salvage of materials, including by no way of limitation the following:

1. Demolition Waste:

a. Asphaltic concrete paving.
b. Concrete.
c. Concrete reinforcing steel.
d. Brick.
e. Concrete masonry units.
f. Wood studs.
g. Wood joists.
h. Plywood and oriented strand board.
i. Wood paneling.
j. Wood trim.
k. Structural and miscellaneous steel.
l. Rough hardware.
m. Roofing.
n. Insulation.
o. Doors and frames.
p. Door hardware.
q. Windows.
r. Glazing.
s. Metal studs.
t. Gypsum board.
u. Acoustical tile and panels.
v. Carpet.
w. Carpet pad.
x. Demountable partitions.
y. Equipment.
z. Cabinets.
aa. Plumbing fixtures.
bb. Piping.

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cc. Supports and hangers.
dd. Valves.
ee. Sprinklers.
ff. Mechanical equipment.
gg. Refrigerants.
hh. Electrical conduit.
ii. Copper wiring.
jj. Lighting fixtures.
kk. Lamps.
ll. Ballasts.
mm. Electrical devices.
nn. Switchgear and panelboards.
oo. Transformers.

2. Construction Waste:

a. Site-clearing waste.
b. Masonry and CMU.
c. Lumber.
d. Wood sheet materials.
e. Wood trim.
f. Metals.
g. Roofing.
h. Insulation.
i. Carpet and pad.
j. Gypsum board.
k. Piping.
l. Electrical conduit.
m. Packaging: Regardless of salvage/recycle goal indicated in paragraph above, salvage or recycle 100 percent of the following uncontaminated packaging materials:

1) Paper.
2) Cardboard.
3) Boxes.
4) Plastic sheet and film.
5) Polystyrene packaging.
6) Wood crates.
7) Plastic pails.

n. Construction Office Waste: Regardless of salvage/recycle goal indicated in "General" Paragraph above, salvage or recycle 100 percent of the following construction office waste materials:

1. Paper.
2. Aluminum cans.
3. Glass containers.

1.8 ACTION SUBMITTALS

A. Waste Management Plan: Submit plan within seven days of date established for commencement of the Works and prior to generation of any waste.

B. Waste management plan to be submitted for Engineer’s approval.

C. Contractor to submit the total estimated construction waste report before the procurement stage for Engineer’s approval.

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D. Contractor to submit a proposal to reduce the construction waste during construction for Engineer's approval.

E. Final Waste Repot: Submit a final waste report for the project that includes the following information:

1. Total construction and demolition waste produced by the project.
2. Types of waste material and quantity of each material.
3. Total waste diverted and diversion rate (percentage).

1.9 INFORMATIONAL SUBMITTALS

A. Waste Reduction Progress Reports: Concurrent with each Application for Payment, submit report. For guidance use Form CWM-7 for construction waste and Form CWM-8 for demolition waste. Include the following information:

1. Material category.
2. Generation points of waste.
3. Total quantity of waste in tonnes.
4. Quantity of waste salvaged, both estimated and actual in tonnes.
5. Quantity of waste recycled, both estimated and actual in tonnes.
6. Total quantity of waste recovered (salvaged plus recycled) in tonnes.
7. Total quantity of waste recovered (salvaged plus recycled) as a percentage of total waste.

B. Waste Reduction Calculations: Before request for Taking Over, submit calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the works.

C. Records of Donations (As Applicable): Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.

D. Records of Sales (As Applicable): Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.

E. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

F. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

G. Sustainability Submittal: Letter template for the Construction and Demolition Waste Management, signed by Contractor, tabulating total waste material, quantities diverted and means by which it is diverted, and statement that requirements have been met.

H. Qualification Data: For waste management coordinator

1.10 QUALITY ASSURANCE

A. Waste Management Coordinator Qualifications: Experienced firm, or individual employed and assigned by Contractor, with a record of successful waste management coordination of Projects with similar requirements. Waste management coordinator may also serve as Sustainability coordinator.

B. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.

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C. Waste Management Conference(s): Conduct conference(s) at Project site to comply with requirements in Division 01 Section 013100 "Project Management and Coordination." Review methods and procedures related to waste management including, but not limited to, the following:

1. Review and discuss waste management plan including responsibilities of waste management coordinator.
2. Review requirements for documenting quantities of each type of waste and its disposition.
3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
5. Review waste management requirements for each trade.

1.11 WASTE MANAGEMENT PLAN

A. General: Develop a waste management plan according to ASTM E 1609 and requirements of this Section. Plan shall consist of waste identification, waste reduction work plan, and cost/revenue analysis. Distinguish between demolition and construction waste. Indicate quantities by weight.

B. Waste Identification: Indicate anticipated types and quantities of demolition site-clearing and construction waste generated by the Works. For guidance use Form CWM-1 for construction waste and Form CWM-2 for demolition waste. Include estimated quantities and assumptions for estimates.

C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. For guidance use Form CWM-3 for construction waste and Form CWM-4 for demolition waste Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.

1. Salvaged Materials for Reuse: For materials that will be salvaged and reused in this Project, describe methods for preparing salvaged materials before incorporation into the Work in compliance with Technical Specifications Sections.
2. Salvaged Materials for Sale: For materials that will be sold to individuals and organizations, include list of their names, addresses, and telephone numbers.
3. Salvaged Materials for Donation: For materials that will be donated to individuals and organizations, include list of their names, addresses, and telephone numbers.
4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.
5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
6. Handling and Transportation Procedures: Include method that will be used for separating recyclable waste including sizes of containers, container labeling, and designated location on Project site where materials separation will be located.

D. Cost/Revenue Analysis: Indicate total cost of waste disposal as if there was no waste management plan and net additional cost or net savings resulting from implementing waste management plan. Use Form CWM-5 for construction waste and Form CWM-6 for demolition waste. Include the following:

1. Total quantity of waste.
2. Estimated cost of disposal (cost per unit). Include hauling and tipping fees and cost of collection containers for each type of waste.
3. Total cost of disposal (with no waste management).
4. Revenue from salvaged materials.
5. Revenue from recycled materials.
6. Savings in hauling and tipping fees by donating materials.
7. Savings in hauling and tipping fees that are avoided.
8. Handling and transportation costs. Include cost of collection containers for each type of waste.

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9. Net additional cost or net savings from waste management plan.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PLAN IMPLEMENTATION

A. General: Implement approved waste management plan. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during the entire duration of the Contract.

1. Comply with Division 01 Section 015000 "Temporary Facilities and Controls" for operation, termination, and removal requirements.

B. Waste Management Coordinator: Engage a waste management coordinator to be responsible for implementing, monitoring, and reporting status of waste management work plan. Coordinator shall be present at Project site full time for duration of Project.

C. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the works occurring at Project site.

1. Distribute waste management plan to everyone concerned within three days of submittal return.
2. Distribute waste management plan to entities when they first begin work on-site. Review plan procedures and locations established for salvage, recycling, and disposal.

D. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

1. Designate and label specific areas on Project site necessary for separating materials that are to be salvaged, recycled, reused, donated, and sold.
2. Comply with Division 01 Section 015000 "Temporary Facilities and Controls" for controlling dust and dirt, environmental protection, and noise control.

3.2 SALVAGING DEMOLITION WASTE

A. Comply with requirements in Technical Specifications Sections for salvaging demolition waste.

B. Salvaged Items for Reuse in the Works: Salvage items for reuse and handle as follows:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until installation.
4. Protect items from damage during transport and storage.
5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.

C. Salvaged Items for Sale and Donation: Permitted on Project site.

D. Salvaged Items for Employer's Use: Salvage items for Employer's use and handle as follows:

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1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to Employer.
4. Transport items to Employer's storage area designated by Employer.
5. Protect items from damage during transport and storage.

E. Doors and Hardware: Brace open end of door frames. Except for removing door closers, leave door hardware attached to doors.

F. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.

G. Plumbing Fixtures: Separate by type and size.

H. Lighting Fixtures: Separate lamps by type and protect from breakage.

I. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.

3.3 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

A. General: Recycle paper and beverage containers used by on-site workers.

B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall be to the benefit of the Contractor.

C. Preparation of Waste: Prepare and maintain recyclable waste materials according to recycling or reuse facility requirements. Maintain materials free of dirt, adhesives, solvents, petroleum contamination, and other substances deleterious to the recycling process.

D. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project site to the maximum extent practical according to approved construction waste management plan.

1. Provide appropriately marked containers or bins for controlling recyclable waste until they are removed from Project site. Include list of acceptable and unacceptable materials at each container and bin.

    a. Inspect containers and bins for contamination and remove contaminated materials if found.

2. Stockpile processed materials on-site without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
4. Store components off the ground and protect from the weather.
5. Remove recyclable waste off Employer's property and transport to recycling receiver or processor as often as required to prevent overfilling bins.

3.4 RECYCLING DEMOLITION WASTE

A. Asphalt Paving: Grind asphalt to maximum 38-mm size.

1. Crush asphaltic concrete paving and screen to comply with requirements in Section 312000 "Earth Moving" for use as general fill.

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B. Asphalt Paving: Break up and transport paving to asphalt-recycling facility.

C. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.

1. Pulverize concrete to maximum 38-mm size.
2. Crush concrete and screen to comply with requirements in Section 312000 "Earth Moving" for use as satisfactory soil for fill or subbase.

D. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.

1. Pulverize masonry to maximum 38-mm size.

a. Crush masonry and screen to comply with requirements in Section 312000 "Earth Moving" for use as general fill or satisfactory soil for fill or subbase.
b. Crush masonry and screen to comply with requirements in Section 329300 "Plants" for use as mineral mulch.

2. Clean and stack undamaged, whole masonry units on wood pallets.

E. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.

F. Metals: Separate metals by type.

1. Structural Steel: Stack members according to size, type of member, and length.
2. Remove and dispose of bolts, nuts, washers, and other rough hardware.

G. Asphalt Shingle Roofing: Separate organic and glass-fiber asphalt shingles and felts. Remove and dispose of nails, staples, and accessories.

H. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.

I. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in a dry location.

J. Metal Suspension System: Separate metal members, including trim and other metals from acoustical panels and tile, and sort with other metals.

K. Carpet and Pad: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.

1. Store clean, dry carpet and pad in a closed container or trailer provided by carpet reclamation agency or carpet recycler.

L. Carpet Tile: Remove debris, trash, and adhesive.

1. Stack tile on pallet and store clean, dry carpet in a closed container or trailer provided by carpet reclamation agency or carpet recycler.

M. Piping: Reduce piping to straight lengths and store by material and size. Separate supports, hangers, valves, sprinklers, and other components by material and size.

N. Conduit: Reduce conduit to straight lengths and store by material and size.

O. Lamps: Separate lamps by type and store according to requirements in 40 CFR 273.

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3.5 RECYCLING CONSTRUCTION WASTE

A. Packaging:

1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in a dry location.
2. Polystyrene Packaging: Separate and bag materials.
3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project site. For pallets that remain on-site, break down pallets into component wood pieces and comply with requirements for recycling wood.
4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

B. Wood Materials:

1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
2. Clean Sawdust: Bag sawdust that does not contain painted or treated wood.

    a. Comply with requirements in Section 329300 "Plants" for use of clean sawdust as organic mulch.

C. Gypsum Board: Stack large clean pieces on wood pallets or in container and store in a dry location.

1. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.

    a. Comply with requirements in Section 329300 "Plants" for use of clean ground gypsum board as inorganic soil amendment.

D. Paint: Seal containers and store by type.

E. Site-Clearing Wastes: Chip brush, branches, and trees at landfill facility.

1. Comply with requirements in Division 32 Section "Plants" for use of chipped organic waste as organic mulch.

3.6 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project site and legally dispose of them in a landfill or incinerator acceptable to authorities having jurisdiction.

1. Except as otherwise specified, do not allow waste materials that are to be disposed of accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.

B. General: Except for items or materials to be salvaged or recycled, remove waste materials and legally dispose of at designated spoil areas on Employer’s property.

C. Burning: Do not burn waste materials.

D. Disposal: Transport waste materials off the property and legally dispose of them.

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3.7 Hazardous Waste

A. Wastes which are deemed to be hazardous to health and/or the environment in accordance with local and international legislation must be identified and managed in accordance with the compliance requirements. This includes providing adequate facilities for the temporary storage and collection, and ensuring treatment and disposal is undertaken as per compliance requirements.

B. Excavated soil, land-clearing debris and hazardous waste must be diverted to places designated by the concerned departments.

3.8 ATTACHMENTS

A. Form CWM-1 for construction waste identification.

B. Form CWM-2 for demolition waste identification.

C. Form CWM-3 for construction waste reduction work plan.

D. Form CWM-4 for demolition waste reduction work plan.

E. Form CWM-5 cost/revenue analysis of construction waste reduction work plan.

F. Form CWM-6 cost/revenue analysis of demolition waste reduction work plan.

G. Form CWM-7 for construction waste reduction progress report.

H. Form CWM-8 for demolition waste reduction progress report.

END OF SECTION 017419

FORM CWM-1: CONSTRUCTION WASTE IDENTIFICATION							
MATERIAL CATEGORY	**GENERATION POINT**	**EST. QUANTITY OF MATERIALS RECEIVED* (A)**	**EST. WASTE - % (B)**	**TOTAL EST. QUANTITY OF WASTE* (C = A x B)**	**EST. VOLUME CY (CM)**	**EST. WEIGHT TONS (TONNES)**	**REMARKS AND ASSUMPTIONS**
Packaging: Cardboard							
Packaging: Boxes							
Packaging: Plastic Sheet or Film							
Packaging: Polystyrene							
Packaging: Pallets or Skids							
Packaging: Crates							
Packaging: Paint Cans							
Packaging: Plastic Pails							
Site-Clearing Waste							
Masonry or CMU							
Lumber: Cut-Offs							
Lumber: Warped Pieces							
Plywood or OSB (scraps)							
Wood Forms							
Wood Waste Chutes							
Wood Trim (cut-offs)							
Metals							
Insulation							
Roofing							
Joint Sealant Tubes							
Gypsum Board (scraps)							
Carpet and Pad (scraps)							
Piping							
Electrical Conduit							
Oil spillage							
Chemical spillage							
Other:							

* Insert units of measure.

FORM CWM-2: DEMOLITION WASTE IDENTIFICATION				
MATERIAL DESCRIPTION	**EST. QUANTITY**	**EST. VOLUME CY (CM)**	**EST. WEIGHT TONS (TONNES)**	**REMARKS AND ASSUMPTIONS**
Asphaltic Concrete Paving				
Concrete				
Brick				
CMU				
Lumber				
Plywood and OSB				
Wood Paneling				
Wood Trim				
Miscellaneous Metals				
Structural Steel				
Rough Hardware				
Insulation				
Roofing				
Doors and Frames				
Door Hardware				
Windows				
Glazing				
Acoustical Tile				
Carpet				
Carpet Pad				
Demountable Partitions				
Equipment				
Cabinets				
Plumbing Fixtures				
Piping				
Piping Supports and Hangers				
Valves				
Sprinklers				
Mechanical Equipment				
Electrical Conduit				
Copper Wiring				
Light Fixtures				
Lamps				
Lighting Ballasts				
Electrical Devices				
Switchgear and Panelboards				
Transformers				
Other:				

FORM CWM-3: CONSTRUCTION WASTE REDUCTION WORK PLAN						
MATERIAL CATEGORY	GENERATION POINT	TOTAL EST. QUANTITY OF WASTE TONS (TONNES)	DISPOSAL METHOD AND QUANTITY			HANDLING AND TRANSPORTATION PROCEDURES
			EST. AMOUNT SALVAGED TONS (TONNES)	EST. AMOUNT RECYCLED TONS (TONNES)	EST. AMOUNT DISPOSED TO LANDFILL TONS (TONNES)	
Packaging: Cardboard						
Packaging: Boxes						
Packaging: Plastic Sheet or Film						
Packaging: Polystyrene						
Packaging: Pallets or Skids						
Packaging: Crates						
Packaging: Paint Cans						
Packaging: Plastic Pails						
Site-Clearing Waste						
Masonry or CMU						
Lumber: Cut-Offs						
Lumber: Warped Pieces						
Plywood or OSB (scraps)						
Wood Forms						
Wood Waste Chutes						
Wood Trim (cut-offs)						
Metals						
Insulation						
Roofing						
Joint Sealant Tubes						
Gypsum Board (scraps)						
Carpet and Pad (scraps)						
Piping						
Electrical Conduit						
Other:						

FORM CWM-4: DEMOLITION WASTE REDUCTION WORK PLAN						
MATERIAL CATEGORY	GENERATION POINT	TOTAL EST. QUANTITY OF WASTE TONS (TONNES)	DISPOSAL METHOD AND QUANTITY			HANDLING AND TRANSPORTATION PROCEDURES
			EST. AMOUNT SALVAGED TONS (TONNES)	EST. AMOUNT RECYCLED TONS (TONNES)	EST. AMOUNT DISPOSED TO LANDFILL TONS (TONNES)	
Asphaltic Concrete Paving						
Concrete						
Brick						
CMU						
Lumber						
Plywood and OSB						
Wood Paneling						
Wood Trim						
Miscellaneous Metals						
Structural Steel						
Rough Hardware						
Insulation						
Roofing						
Doors and Frames						
Door Hardware						
Windows						
Glazing						
Acoustical Tile						
Carpet						
Carpet Pad						
Demountable Partitions						
Equipment						
Cabinets						
Plumbing Fixtures						
Piping						
Supports and Hangers						
Valves						
Sprinklers						
Mechanical Equipment						
Electrical Conduit						
Copper Wiring						
Light Fixtures						
Lamps						
Lighting Ballasts						
Electrical Devices						
Switchgear and Panelboards						
Transformers						
Other:						

FORM CWM-5: COST/REVENUE ANALYSIS OF CONSTRUCTION WASTE REDUCTION WORK PLAN								
MATERIALS	TOTAL QUANTITY OF MATERIALS (VOL. OR WEIGHT) (A)	EST. COST OF DISPOSAL (B)	TOTAL EST. COST OF DISPOSAL (C = A x B)	REVENUE FROM SALVAGED MATERIALS (D)	REVENUE FROM RECYCLED MATERIALS (E)	LANDFILL TIPPING FEES AVOIDED (F)	HANDLING AND TRANSPORTATION COSTS AVOIDED (G)	NET COST SAVINGS OF WORK PLAN (H = D+E+F+G)
Packaging: Cardboard								
Packaging: Boxes								
Packaging: Plastic Sheet or Film								
Packaging: Polystyrene								
Packaging: Pallets or Skids								
Packaging: Crates								
Packaging: Paint Cans								
Packaging: Plastic Pails								
Site-Clearing Waste								
Masonry or CMU								
Lumber: Cut-Offs								
Lumber: Warped Pieces								
Plywood or OSB (scraps)								
Wood Forms								
Wood Waste Chutes								
Wood Trim (cut-offs)								
Metals								
Insulation								
Roofing								
Joint Sealant Tubes								
Gypsum Board (scraps)								
Carpet and Pad (scraps)								
Piping								
Electrical Conduit								
Other:								

FORM CWM-6: COST/REVENUE ANALYSIS OF DEMOLITION WASTE REDUCTION WORK PLAN								
MATERIALS	TOTAL QUANTITY OF MATERIALS (VOL. OR WEIGHT) (A)	EST. COST OF DISPOSAL (B)	TOTAL EST. COST OF DISPOSAL (C = A x B)	REVENUE FROM SALVAGED MATERIALS (D)	REVENUE FROM RECYCLED MATERIALS (E)	LANDFILL TIPPING FEES AVOIDED (F)	HANDLING AND TRANSPORTATION COSTS AVOIDED (G)	NET COST SAVINGS OF WORK PLAN (H = D+E+F+G)
Asphaltic Concrete Paving								
Concrete								
Brick								
CMU								
Lumber								
Plywood and OSB								
Wood Paneling								
Wood Trim								
Miscellaneous Metals								
Structural Steel								
Rough Hardware								
Insulation								
Roofing								
Doors and Frames								
Door Hardware								
Windows								
Glazing								
Acoustical Tile								
Carpet								
Carpet Pad								
Demountable Partitions								
Equipment								
Cabinets								
Plumbing Fixtures								
Piping								
Supports and Hangers								
Valves								
Sprinklers								
Mech. Equipment								
Electrical Conduit								
Copper Wiring								
Light Fixtures								
Lamps								
Lighting Ballasts								
Electrical Devices								
Switchgear and Panelboards								
Transformers								
Other:								

FORM CWM-7: CONSTRUCTION WASTE REDUCTION PROGRESS REPORT								
MATERIAL CATEGORY	GENERATION POINT	TOTAL QUANTITY OF WASTE TONS (TONNES) (A)	QUANTITY OF WASTE SALVAGED		QUANTITY OF WASTE RECYCLED		TOTAL QUANTITY OF WASTE RECOVERED TONS (TONNES) (D = B + C)	TOTAL QUANTITY OF WASTE RECOVERED % (D / A x 100)
			ESTIMATED TONS (TONNES)	ACTUAL TONS (TONNES) (B)	ESTIMATED TONS (TONNES)	ACTUAL TONS (TONNES) (C)		
Packaging: Cardboard								
Packaging: Boxes								
Packaging: Plastic Sheet or Film								
Packaging: Polystyrene								
Packaging: Pallets or Skids								
Packaging: Crates								
Packaging: Paint Cans								
Packaging: Plastic Pails								
Site-Clearing Waste								
Masonry or CMU								
Lumber: Cut-Offs								
Lumber: Warped Pieces								
Plywood or OSB (scraps)								
Wood Forms								
Wood Waste Chutes								
Wood Trim (cut-offs)								
Metals								
Insulation								
Roofing								
Joint Sealant Tubes								
Gypsum Board (scraps)								
Carpet and Pad (scraps)								
Piping								
Electrical Conduit								
Other:								

FORM CWM-8: DEMOLITION WASTE REDUCTION PROGRESS REPORT								
MATERIAL CATEGORY	GENERATION POINT	TOTAL QUANTITY OF WASTE TONS (TONNES) (A)	QUANTITY OF WASTE SALVAGED		QUANTITY OF WASTE RECYCLED		TOTAL QUANTITY OF WASTE RECOVERED TONS (TONNES) (D = B + C)	TOTAL QUANTITY OF WASTE RECOVERED % (D / A x 100)
			ESTIMATED TONS (TONNES)	ACTUAL TONS (TONNES) (B)	ESTIMATED TONS (TONNES)	ACTUAL TONS (TONNES) (C)		
Asphaltic Concrete Paving								
Concrete								
Brick								
CMU								
Lumber								
Plywood and OSB								
Wood Paneling								
Wood Trim								
Miscellaneous Metals								
Structural Steel								
Rough Hardware								
Insulation								
Roofing								
Doors and Frames								
Door Hardware								
Windows								
Glazing								
Acoustical Tile								
Carpet								
Carpet Pad								
Demountable Partitions								
Equipment								
Cabinets								
Plumbing Fixtures								
Piping								
Supports and Hangers								
Valves								
Sprinklers								
Mechanical Equipment								
Electrical Conduit								
Copper Wiring								
Light Fixtures								
Lamps								
Lighting Ballasts								
Electrical Devices								
Switchgear and Panelboards								
Transformers								
Other:								

SECTION 017700 - CLOSEOUT PROCEDURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions and other Division 01 Specifications sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for Contract Closeout, including, but not limited to, the following:

1. Substantial Completion procedures.

2. Final Completion procedures.

3. List of Incomplete Items (Punch list).

4. Submittal of Project Warranties.

5. Final cleaning.

B. Related Requirements:

1. Division 01 Section 013233 "Photographic Documentation" for submitting Final Completion construction photographic documentation.

2. Division 01 Section 017823 "Operation and Maintenance Data" for additional operation and maintenance manual requirements.

3. Division 01 Section 017839 "Project Record Documents" for submitting Record Drawings, Record Specifications, and Record Product Data.

4. Division 01 Section 017900 "Demonstration and Training" for requirements to train the Employer's maintenance personnel to adjust, operate, and maintain products, equipment, and systems.

1.3 DEFINITIONS

A. List of Incomplete Items (Punch list): Contractor-prepared list of items to be completed or corrected, prepared for the Engineer's use prior to Engineer's inspection, to determine if the Work is substantially complete.

B. (COBie): Construction-Operations Building Information Exchange.

C. Punch List: Snag List.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of cleaning agent.

B. Contractor's List of Incomplete Items: Initial submittal at Substantial Completion.

C. Certified List of Incomplete Items: Final submittal at Final Completion.

1.5 CLOSEOUT SUBMITTALS

A. Certificates of Release: From authorities having jurisdiction.

B. Certificate of Insurance: For continuing coverage.

C. Field Report: For pest-control inspection.

1.6 MAINTENANCE MATERIAL SUBMITTALS

A. Schedule of Maintenance Material Items: For maintenance material submittal items required by other Sections.

1.7 SUBSTANTIAL COMPLETION PROCEDURES

A. Contractor's List of Incomplete Items: Prepare and submit a list of items to be completed and corrected (Contractor's "punch list"), indicating the value of each item on the list and reasons why the Work is incomplete.

B. Submittals Prior to Substantial Completion: Complete the following a minimum of **[ten (10)]** days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Certificates of Release: Obtain and submit releases from authorities having jurisdiction, permitting Employer unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.

2. Submit Closeout submittals specified in other Division 01 Sections, including Project Record drawings and documents BIM deliverables, As-Built Models, operation and maintenance manuals, damage or settlement surveys, property surveys, HSSE File and similar final record information.

3. Submit Closeout submittals specified in individual Sections, including specific warranties, Construction bonds, maintenance service agreements, final certifications, and similar documents.

4. Submit maintenance material submittals specified in individual Sections, including tools, spare parts, extra materials, and similar items, and deliver to location designated by Engineer. Label with manufacturer's name and model number.

    a. Schedule of Maintenance Material Items: Prepare and submit schedule of maintenance material submittal items, including name and quantity of each item and name and number of related Specification Section. Obtain Engineer's signature for receipt of submittals.

5. Submit testing, adjusting, and balancing records.

6. Submit sustainable design submittals not previously submitted.

7. Submit changeover information related to Employer's occupancy, use, operation, and maintenance.

8. Submit a written undertaking in a form acceptable to the Engineer, to complete and / or correct all items contained in the punch list, to the satisfaction of the Engineer, within twenty eight (28) days from date of issue of the Substantial Completion Certificate.

9. Submit warranties, bonds, maintenance service agreements, final certifications, and similar documents.

C. Procedures Prior to Substantial Completion: Complete the following a minimum of ten (10) days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.

1. Advise Employer of pending insurance changeover requirements.

2. Make final changeover of permanent locks and deliver keys to Employer. Advise Employer's personnel of changeover in security provisions.

3. Complete startup and testing of systems and equipment.

4. Perform preventive maintenance on equipment used prior to Substantial Completion.

5. Instruct Employer's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings specified in Section 017900 "Demonstration and Training."

6. Advise Employer of changeover in utility services.

7. Participate with Employer in conducting inspection and walkthrough with local emergency responders.

8. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.

9. Complete final cleaning requirements.

10. Touch up paint and otherwise repair and restore marred exposed finishes to eliminate visual defects.

11. Prepare and submit Project Record Documents, operation and maintenance manuals, final complete construction photographic documentation, damage or settlement surveys, property surveys, and similar final record information.

12. Deliver tools, spare parts, extra materials, and similar items to location designated by Employer. Label with manufacturer's name and model number where applicable.

D. Inspection: Submit a written request for inspection to determine Substantial Completion a minimum of ten (10) days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, the Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of items, either on Contractor's list or additional items identified by Engineer, that must be completed or corrected before certificate will be issued.

1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

2. Results of completed inspection will form the basis of requirements for Final Completion.

G. BIM Deliverables: During Construction stage, the Contractor shall develop the asset management strategy as defined during design stage and agreed with Employer global asset management strategy by delivering an Asset Information Model (AIM) in accordance of the following requirements:

1. BIM Models characteristics:

   a. BIM digital assets (3D families) with required level of geometry as per the DTRD guidelines matrix.

   b. Each asset digital family shall have the required asset information attributes including asset ID, COBie parameters, classification codes.

   c. Exported Model elements geometry should be simplified to relay needed information without causing performance issues.

   d. BIM models to be compatible with other third-party platforms as IFC ready.

   e. BIM models to be georeferenced to be compatible with AR/VR devices.

   f. Size of models should be optimized for mobile platforms.

2. BIM Models Content and Information requirements:

   a. Provide different virtual zoning entities and sub-entities (facilities, floors, zones, spaces…) These zoning entities will be modeled as 3D volumes and assigned specific ID's for mapping with the digital platform for enhanced visualizations.

   b. Modeling new elements/provisions for future Digital Twin applications in accordance with agreed use cases.

   c. Progressive update of BIM models and publishing in different digital twin friendly software formats.

   d. COBie schema production for flexibility of integration with different digital platforms. The COBie schema will also provide the asset grouping breakdown structure in a parent-child data link.

   e. Models should be verified against site conditions in terms of overall dimensions and geospatial location to meet LOD 500 requirements.

   f. Project model division and WBS to take into consideration potential Construction/Operation phases modeling requirements at IFC.

   g. Coordination of project to take into consideration sensors and other IOTs potential locations and maintenance requirements.

H. BIM Deliverables: During Construction stage and prior handing over, the Contractor shall develop the As-Built strategy as defined during tender stage and agreed with Employer and Engineer by delivering a Project Information Model (PIM) in accordance of the following requirements:

1. BIM Models characteristics:

   a. Models should be verified against site conditions in terms of overall dimensions and geospatial location to meet LOD 500 requirements.

   b. Each digital family shall have the required information attributes as specified in project BEP and project information requirements LOI 500.

c. BIM Model shall be updated as per actual site conditions, red markup drawings.

d. Non-editable Federated BIM model (NWD) shall be submitted showing laser scanned point cloud (where applicable and as per project requirements) vs as-built updated model.

1.8 FINAL COMPLETION PROCEDURES

A. Submittals Prior to Final Completion: Before requesting final inspection for determining Final Completion, complete the following:

1. Submit a final Application for Payment.

2. Certified List of Incomplete Items: Submit certified copy of Engineer's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by Engineer. Certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.

3. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.

4. Submit pest-control final inspection report.

5. Submit Final Completion photographic documentation.

B. Inspection: Submit a written request for final inspection to determine acceptance a minimum of 10 days prior to date the Work will be completed and ready for final inspection and tests. On receipt of request, Engineer will either proceed with inspection or notify Contractor of unfulfilled requirements. Engineer will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.

1. Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

1.9 LIST OF INCOMPLETE ITEMS (PUNCH LIST)

A. Organization of List: Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.

1. Organize list of spaces in sequential order, listed by room or space number.

2. Organize items applying to each space by major element, including categories for ceilings, individual walls, floors, equipment, and building systems.

3. Include the following information at the top of each page:

a. Project name.

b. Date.

c. Name of Engineer [and Construction Manager].

d. Name of Contractor.

e. Page number.

4. Submit list of incomplete items in the following format:

    a. MS Excel Electronic File: The Engineer will return annotated file.

    b. PDF Electronic File: The Engineer will return annotated file.

    c. Web-Based Project Software Upload: Utilize software feature for creating and updating list of incomplete items (punch list).

    d. Three (3) Paper Copies: The Engineer will return one (1) copy.

1.10 SUBMITTAL OF PROJECT WARRANTIES

A. Time of Submittal: Submit written warranties on request of Engineer for designated portions of the Work where warranties are indicated to commence on dates other than date of Substantial Completion, or when delay in submittal of warranties might limit Employer's rights under warranty.

B. Partial Occupancy: Submit properly executed warranties within fifteen (15) days of completion of designated portions of the Work that are completed and occupied or used by Employer during construction period by separate agreement with Contractor.

C. Organize warranty documents into an orderly sequence based on the table of contents of Project Manual.

D. Warranty Electronic File: Provide warranties and bonds in PDF format. Assemble complete warranty and bond submittal package into a single electronic PDF file with bookmarks enabling navigation to each item. Provide bookmarked table of contents at beginning of document.

    1. Submit on digital media acceptable to Engineer by uploading to web-based project software site by email to Engineer.

E. Warranties in Paper Form:

    1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 215-by-280-mm paper.

    2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.

    3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.

F. Provide additional copies of each warranty to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

1. Use cleaning products that comply with Green Seal's GS-37, or if GS-37 is not applicable, use products that comply with the California Code of Regulations maximum allowable VOC levels.

PART 3 - EXECUTION

3.1 FINAL CLEANING

A. General: Perform final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete the following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a designated portion of Project:

a. Clean Project site of rubbish, waste material, litter, and other foreign substances.

b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.

c. Rake grounds that are not planted, mulched, or paved to a smooth, even-textured surface.

d. Remove tools, construction equipment, machinery, and surplus material from Project site.

e. [Remove snow and ice to provide safe access to building.

f.]Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.

g. Remove debris and surface dust from limited-access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.

h. Clean flooring, removing debris, dirt, and staining; clean in accordance with manufacturer's instructions.

i. Vacuum and mop concrete.

j. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean in accordance with manufacturer's instructions if visible soil or stains remain.

k. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.

l. Remove labels that are not permanent.

m. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.

n. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.

o. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.

p. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection].

1) Clean HVAC system in compliance with NADCA ACR and all relevant HVAC outline specifications. Provide written report on completion of cleaning.

q. Clean luminaires, lamps, globes, and reflectors to function with full efficiency.

r. Clean strainers.

s. Leave Project clean and ready for occupancy.

C. Pest Control: Comply with pest control requirements in Section 015000 "Temporary Facilities and Controls." Prepare written report.

D. Construction Waste Disposal: Comply with waste-disposal requirements in Section 015000 "Temporary Facilities and Controls.", Section 017419 "Construction Waste Management and Disposal."

E. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the Employer's property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Site and dispose of lawfully.

3.2 CORRECTION OF THE WORK

A. Complete repair and restoration operations required by "Correction of the Work" Article in Section 017300 "Execution" before requesting inspection for determination of Substantial Completion.

END OF SECTION 017700

SECTION 017823 - OPERATION AND MAINTENANCE DATA

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions and other Division 01 Specifications sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:

1. Operation and maintenance documentation directory manuals.
2. Emergency manuals.
3. Systems and equipment operation manuals.
4. Systems and equipment maintenance manuals.
5. Product maintenance manuals.

B. Related Requirements:

1. Section 011200 "Multiple Contract Summary" for coordinating operation and maintenance manuals covering the Work of multiple contracts.
2. Section 013300 "Submittal Procedures" for submitting copies of submittals for operation and maintenance manuals.
3. Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.
4. Section 019113 "General Commissioning Requirements" for verification and compilation of data into operation and maintenance manuals.
5. Specification sections related to the functionality and efficiency of the executed systems.

1.3 DEFINITIONS

A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.

B. Subsystem: A portion of a system with characteristics similar to a system.

1.4 QUALITY ASSURANCE

A. O&M Manual Preparation: In preparation of O&M Manuals, use personnel thoroughly trained and experienced in operation and maintenance of equipment or system involved.

1. Where O&M Manuals require written instructions, use personnel skilled in technical writing where necessary for communication of essential data.
2. Where O&M Manuals require drawings or diagrams, use CAD / BIM operators or drafters (as applicable) capable of preparing drawings or models clearly in a clear, understandable industry standard format.
3. Develop System-Level O&M Manuals for mechanical and electrical systems specifically for this Project. Compilation of equipment vendor catalogues and O&M Manuals is not acceptable.

B. Instructions for the Employer's Personnel: Use experienced instructors thoroughly trained and experienced in operation and maintenance of equipment or system involved to instruct the Employer's O&M personnel.

1.5 CLOSEOUT SUBMITTALS

A. Submit operation and maintenance manuals indicated. Provide content for each manual as specified in individual Specification Sections, and as reviewed and approved at the time of Section submittals. Submit reviewed manual content formatted and organized as required by this Section.

1. The Engineer and Commissioning Authority will comment on whether content of operation and maintenance submittals is acceptable.
2. Where applicable, clarify and update reviewed manual content to correspond to revisions and field conditions.

B. Format: Submit operation and maintenance manuals in the following format:

1. PDF digital copies. Enable reviewer comments on draft submittals.
2. One (1) original and three (3)paper copies.

C. Initial Manual Submittal: Submit draft copy of each manual at least thirty (30) days before commencing demonstration and training. The Engineer and Commissioning Authority will comment on whether general scope and content of manual are acceptable.

D. Final Manual Submittal: Submit each manual in final form prior to requesting inspection for Substantial Completion and at least fifteen (15) days before commencing demonstration and training. The Engineer and Commissioning Authority will return copy with comments.

1. Correct or revise each manual to comply with The Engineer’s and Commissioning Authority's comments. Submit copies of each corrected manual within [fifteen (15)] days of receipt of The Engineer’s and Commissioning Authority's comments and prior to commencing demonstration and training.

E. Comply with Section 017700 "Closeout Procedures" for schedule for submitting operation and maintenance documentation.

1.6 FORMAT OF OPERATION AND MAINTENANCE MANUALS

A. Manuals, Electronic Files: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.

1. Electronic Files: Use electronic files prepared by manufacturer where available. Where scanning of paper documents is required, files shall be in a PDF format at a resolution of at least 300 DPI, optimized for readability.
2. File Names and Bookmarks: Bookmark individual documents based on file names. Name document files to correspond to system, subsystem, and equipment names used in manual directory and table of contents. Group documents for each system and subsystem into individual composite bookmarked files, then create composite manual, so that resulting bookmarks reflect the system, subsystem, and equipment names in a readily navigated file tree. Configure electronic manual to display bookmark panel on opening file.

B. Manuals, Paper Copy: Submit manuals in the form of hard copy, bound and labeled volumes.

1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf, post-type binders, in thickness necessary to accommodate contents, sized to hold 215-by-280 mm paper; with clear plastic

sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.

a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents, and indicate Specification Section number on bottom of spine]. Indicate volume number for multiple-volume sets.

2. Dividers: Heavy-paper dividers with plastic-covered tabs for each section of the manual. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to Specification Section number and title of Project Manual.
3. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software storage media for computerized electronic equipment. Enclose title pages and directories in clear plastic sleeves.
4. Supplementary Text: Prepared on 215 by 280-mm white bond paper.
5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.

a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

1.7 REQUIREMENTS FOR EMERGENCY, OPERATION, AND MAINTENANCE MANUALS

A. Organization of Manuals: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:

1. Title page.
2. Table of contents.
3. Manual contents.

B. Title Page: Include the following information:

1. Subject matter included in manual.
2. Name and address of Project.
3. Name and address of Employer.
4. Date of submittal.
5. Name and contact information for Contractor.
6. Name and contact information for Construction Manager.
7. Name and contact information for The Engineer.
8. Name and contact information for Commissioning Authority.
9. Names and contact information for major consultants to the Engineer that designed the systems contained in the manuals.
10. Cross-reference to related systems in other operation and maintenance manuals.

C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in Project Manual.

1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.

E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4-2019, "Preparation of Operating and Maintenance Documentation for Building Systems."

1.8 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY MANUAL

A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals. List items and their location to facilitate ready access to desired information. Include the following:

1. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
2. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
3. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.

1.9 EMERGENCY MANUALS

A. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Employer's operating personnel for types of emergencies indicated.

B. Content: Organize manual into a separate section for each of the following:

1. Type of emergency.
2. Emergency instructions.
3. Emergency procedures.

C. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:

1. Fire.
2. Flood.
3. Gas leak.
4. Water leak.
5. Power failure.
6. Water outage.
7. System, subsystem, or equipment failure.
8. Chemical release or spill.

D. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Employer's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

E. Emergency Procedures: Include the following, as applicable:

1. Instructions on stopping.
2. Shutdown instructions for each type of emergency.
3. Operating instructions for conditions outside normal operating limits.
4. Required sequences for electric or electronic systems.
5. Special operating instructions and procedures.

1.10 SYSTEMS AND EQUIPMENT OPERATION MANUALS

A. Systems and Equipment Operation Manual: Assemble a complete set of data indicating operation of each system, subsystem, and piece of equipment not part of a system. Include information required for daily operation and management, operating standards, and routine and special operating procedures.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Employer's operating personnel.

B. Content: In addition to requirements in this Section, include operation data required in individual Specification Sections and the following information:

1. System, subsystem, and equipment descriptions. Use designations for systems and equipment indicated on Contract Documents.
2. Performance and design criteria if Contractor has delegated design responsibility.
3. Operating standards.
4. Operating procedures.
5. Operating logs.
6. Wiring diagrams.
7. Control diagrams.
8. Piped system diagrams.
9. Precautions against improper use.
10. License requirements including inspection and renewal dates.

C. Descriptions: Include the following:

1. Product name and model number. Use designations for products indicated on Contract Documents.
2. Manufacturer's name.
3. Equipment identification with serial number of each component.
4. Equipment function.
5. Operating characteristics.
6. Limiting conditions.
7. Performance curves.
8. Engineering data and tests.
9. Complete nomenclature and number of replacement parts.

D. Operating Procedures: Include the following, as applicable:

1. Startup procedures.
2. Equipment or system break-in procedures.
3. Routine and normal operating instructions.
4. Regulation and control procedures.
5. Instructions on stopping.
6. Normal shutdown instructions.
7. Seasonal and weekend operating instructions.
8. Required sequences for electric or electronic systems.
9. Special operating instructions and procedures.

E. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

F. Piped Systems: Diagram piping as installed and identify color coding where required for identification.

1.11 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Systems and Equipment Maintenance Manuals: Assemble a complete set of data indicating maintenance of each system, subsystem, and piece of equipment not part of a system. Include manufacturers' maintenance documentation, preventive maintenance procedures and frequency, repair procedures, wiring and systems diagrams, lists of spare parts, and warranty information.

1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Employer's operating personnel.

B. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranties and bonds as described below.

C. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Manufacturers' Maintenance Documentation: Include the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins; include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.

    a. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.

2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

E. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:

1. Test and inspection instructions.
2. Troubleshooting guide.
3. Precautions against improper maintenance.
4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
5. Aligning, adjusting, and checking instructions.
6. Demonstration and training video recording, if available.

F. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

G. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

H. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

I. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

J. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.

1. Do not use original project record documents as part of maintenance manuals.

1.12 PRODUCT MAINTENANCE MANUALS

A. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.

B. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

C. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

D. Product Information: Include the following, as applicable:

1. Product name and model number.
2. Manufacturer's name.
3. Color, pattern, and texture.
4. Material and chemical composition.
5. Reordering information for specially manufactured products.

E. Maintenance Procedures: Include manufacturer's written recommendations and the following:

1. Inspection procedures.
2. Types of cleaning agents to be used and methods of cleaning.
3. List of cleaning agents and methods of cleaning detrimental to product.
4. Schedule for routine cleaning and maintenance.
5. Repair instructions.

F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.

1. Include procedures to follow and required notifications for warranty claims.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 017823

SECTION 017836 - WARRANTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions and other Division 01 Specifications sections, apply to this Section.

1.2 SUMMARY

A. Section Includes: General requirements for written warranties, guaranties, and bonds required by the Contract Documents.

B. Referenced Documents and Sections:

1. Division 01 Section 016000 “Product Requirements”: Product Warranties.
2. Division 01 Section 017700 “Closeout Procedures”: Submittal of warranties, guaranties, and bonds as a condition of Substantial Completion
3. Division 01 Section 017823 “Operating and Maintenance Data: Incorporation of warranties, guaranties, and bonds into instruction manuals.
4. Specification sections for warranty clauses specified.

C. Approval of the warranties, guaranties, and bonds by the Employer is a prerequisite to final payment under the Contract.

1.3 GENERAL

A. Deliver warranties, guaranties, and bonds required by Contract Documents as stated in the General Conditions, with Employer named as beneficiary.

B. Complete System Warranty: Provide complete system warranty in which Manufacturer and Installer are jointly and severally liable and agree to repair or replace all defective components of the warranted system. The warranty shall include both materials and workmanship.

C. Additional / Extended Warranties for the HVAC and Electrical Equipment: Provide additional/extended warranties for all HVAC and electrical equipment put into early operation for the supply of Wild Air to cover the operation period of the equipment from the Wild Air On date to the Date of Substantial Completion of the Works. Manufacturers’ Warranty Certificates shall be submitted which specifically cover this period related to the provision of Wild Air. The provision of these additional/extended warranties is in addition to the warranties required for the stated period after the Date of Substantial Completion.

D. Warranty shall include:

1. Defective materials and installation.
2. Failure to comply with requirements stated in technical specifications.
3. Structural failures including, but not limited to, excessive deflection.
4. Faulty operation of movable parts such as hardware.
5. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
6. Delamination of exterior or interior facing materials.

7. Making goods and installation and finishing all items that are disturbed and that may be required due to repair or replacement of defective items. Coordinate with Employer, manufacturer, and installer of adjacent disturbed items to ensure that their warranty is not cancelled due to the repair work.

E. Limitations: state the limitations of the warranty as agreed with Engineer / Employer.

F. Warranty Period: Warranties shall come into force from the date of Substantial Completion. Refer to sections in each project specifications which include warranty clauses with warranty periods. Where the Project Specifications do not specify a warranty period, the warranty period shall be in accordance with the Manufacturer's standard warranty.

1.4 WARRANTY / GUARANTY FORM

A. Submit paper and PDF digital copies of warranties and guaranties, on the Contractor's, subcontractor's, material supplier's, or manufacturer's own letterhead, addressed to Employer.

B. Submit warranties and guaranties in duplicate, in the form indicated, signed by cognizant entities, including Contractor in every case, with modifications as approved by Employer to suit the conditions pertaining to the warranty or guaranty.

1.5 SUBMITTAL

A. Collect and assemble written warranties and guaranties as instructed in Division 01 Section 017700 "Closeout Procedures" and submit to Engineer for delivery to Employer for final review and approval.

1.6 TERMS

A. In addition to specific product requirements, Contractor agrees to repair or replace defective materials, workmanship, or failures in a timely, satisfactory manner at no cost to the Employer.

PART 2 - PRODUCTS (Not used)

PART 3 - EXECUTION (Not used)

END OF SECTION 017836

SECTION 017839 - PROJECT RECORD DOCUMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions, and other Division 01 Specifications sections, apply to this Section.

1.2 SUMMARY

A. Section includes administrative and procedural requirements for Project Record Documents, including the following:

1. Record Drawings.
2. Record Specifications.
3. Record Product Data.
4. Miscellaneous Record Submittals.

B. Related Requirements:

1. Division 01 Section 011200 "Multiple Contract Summary" for coordinating Project Record Documents covering the Work of multiple contracts.
2. Division 01 Section 013300 “Submittal Procedures” for use and submission of digital data files.
3. Division 01 Section 017300 "Execution" for final property survey.
4. Division 01 Section 017700 "Closeout Procedures" for general Closeout procedures.
5. Division 01 Section 017823 "Operation and Maintenance Data" for operation and maintenance manual requirements.
6. Specifications Sections for specific requirements for project Record (As-Built) Documents of the Work in those Sections.
7. Specification Sections for specific requirements for Miscellaneous Record keeping and submittal in those Sections.
8. Specification sections related to the functionality and efficiency of the executed systems.

1.3 CLOSEOUT SUBMITTALS

A. BIM File Incorporation: Develop and submit the Project Information Model (PIM) As-built Model(s) ready for integration with Digital Twin Platform, to the level specified in Section 013300 and annexes, and submit the extracted As-built Drawing files in the following order:

1. The Contractor shall submit the Federated BIM As-built Model(s) ready for integration with Digital Twin Platform to the Engineer to facilitate his coordination review of the as-built drawings.
2. The Contractor shall extract the As-Built drawings and details from the native file As-built Model(s) and submit them to the Engineer’s approval. The relevant Federated/Composite BIM Model (NWD) ready for integration with Digital Twin Platform is provided to the Engineer to facilitate his coordination review of the as-built drawings.
3. The Contractor shall use the updated BIM Model(s) to produce all as-built drawings and data and shall submit such drawings and data to the Engineer for approval as per the Specification requirements.
4. The Project As-built BIM Model: upon completion of the Project, the Contractor shall hand over to the Engineer.

5. The Project As-built BIM Model ready for integration with Digital Twin Platform developed as per Section 013300 and its Annexes and this Section, reflecting all As-Built conditions, items 1.3B, C, D and E and including all relevant handover documents (warranties, Operation and Maintenance (O&M) Manuals, commissioning reports, plans, product submittals, etc.).
6. The Project As-built BIM Model shall be submitted to the Engineer for review and verification on the overall quality and comprehensiveness of the Model in reflecting these requirements.

B. Record Drawings: Comply with the following:

1. Number of Copies: Submit two (2) set(s) of marked-up record prints.
2. Submit PDF electronic files of scanned record prints and one (1) set(s) of file prints.
3. Number of Copies: Submit copies of Record Drawings as follows:

    a. Initial Submittal:

        1) Submit one (1) paper-copy set(s) of marked-up record prints.
        2) Submit PDF electronic files of scanned record prints and one (1) set(s) of file prints.
        3) Submit Record Digital Data Files and one (1) set(s) of plots.
        4) The Engineer will initial and date one set of drawings and mark whether general scope of changes, additional information recorded, and quality of drafting are acceptable.

4. Final Submittal: After incorporating the Engineer's initial submittal review comments, submit:

    1) Submit two (2) paper-copy set(s) of marked-up record prints.
    2) Submit PDF electronic files of scanned Record Prints and one (1) set(s) of file prints.
    3) Print each drawing, whether or not changes and additional information were recorded.
    4) Comply with Part 1.4 of section 017823 “Operation & Maintenance Data” for number of sets required for the O&M Manual.

5. Final Submittal:

    a. Submit two (2) paper-copy set(s) of marked-up record prints.
    b. Submit Record Digital Data Files and one (1) set(s) of Record Digital Data File drawings.
    c. Plot each drawing file, whether or not changes and additional information were recorded.

C. Record Specifications: Submit annotated PDF electronic files and one (1) paper copies of Project's Specifications, including addenda and Contract modifications.

D. Record Product Data: Submit annotated PDF electronic files and directories and one (1) paper copies of each submittal.

1. Where record Product Data are required as part of operation and maintenance manuals, submit duplicate marked-up Product Data as a component of manual.

E. Miscellaneous Record Submittals: See to other Specification Sections for miscellaneous record-keeping requirements and submittals in connection with various construction activities. Submit annotated PDF electronic files and directories and one (1) paper copie(s) of each submittal.

F. Reports: Submit written weekly report indicating items incorporated into Project Record Documents concurrent with progress of the Work, including revisions, concealed conditions, field changes, product selections, and other notations incorporated.

1.4 RECORD DRAWINGS

A. Record Prints: Print and maintain one (1) set of marked-up paper copies of the Contract Drawings and Shop Drawings, incorporating new and revised drawings as modifications are issued.

1. Preparation: Mark record prints to show the actual installation, where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to provide information for preparation of corresponding marked-up record prints.

a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
b. Accurately record information in an acceptable drawing technique.
c. Record data as soon as possible after obtaining it.
d. Record and check the markup before enclosing concealed installations.
e. Cross-reference record prints to corresponding photographic documentation.

2. Content: Types of items requiring marking include, but are not limited to, the following:

a. Dimensional changes to Drawings.
b. Revisions to details shown on Drawings.
c. Depths of foundations.
d. Locations and depths of underground utilities.
e. Revisions to routing of piping and conduits.
f. Revisions to electrical circuitry.
g. Actual equipment locations.
h. Duct size and routing.
i. Locations of concealed internal utilities.
j. Changes made by Change Order or Construction Change Directive.
k. Changes made following the Engineer's written orders.
l. Details not on the original Contract Drawings.
m. Field records for variable and concealed conditions.
n. Record information on the Work that is shown only schematically.
o. All coordinates shown on the drawings shall be in accordance with the system agreed with the Engineer.

3. Mark the Contract Drawings and Shop Drawings completely and accurately. Use personnel proficient at recording graphic information in production of marked-up record prints.
4. Mark record prints with erasable, red-colored pencil. Use other colors to distinguish between changes for different categories of the Work at same location.
5. Mark important additional information that was either shown schematically or omitted from original Drawings.
6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.

B. Newly Prepared Record Drawings: Prepare new Drawings where the Engineer determines that neither the original Contract Drawings nor Shop Drawings are suitable to show actual installation.

1. New Drawings may be required when a Variation is issued or as a result of the Engineer accepting an alternate, substitution, or other modification.
2. Consult with the Engineer for proper scale and scope of detailing and notations required to record the actual physical installation and its relation to other construction. Integrate newly prepared Record Drawings into Record Drawing sets; comply with procedures for formatting, organizing, copying, binding, and submitting.

3. Reflect the Newly Prepared Record Drawings information extracted from the BIM Model(s) on a continuous basis utilizing Reality capture.

C. Progress Review: Unless otherwise indicated or directed, submit a copy of marked-up Record Prints and newly prepared Record Drawings at monthly intervals, for progress review and acceptance by the Engineer.

1. Limit submittals to drawings marked-up, prepared or further amended since previous submittal. List drawings contained in each submittal on transmittal form.

D. Record CAD Drawings: Before requesting inspection for determining date of Substantial Completion, review marked-up final Record Prints with the Engineer. When authorized, prepare a full set of CAD Drawings of all Contract Drawings, Shop Drawings and newly prepared Drawings, whether changes or additional information are recorded:

1. Incorporate changes and additional information previously marked on Record Prints. Delete, redraw, and add details and notations where applicable.
2. Refer instances of uncertainty to the Engineer for resolution.
3. Identify and date each Record Drawing; include the designation "RECORD (AS-BUILT) DRAWING" in a prominent location.
4. Record CAD Drawing: Produce a full set of Record Drawings from completed Record CAD Drawing files.
5. Format:

    a. Paper Submittals: Organize record prints into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
    b. Annotated PDF electronic file with comment function enabled.
    c. As-Built BIM Models ready for integration with Digital Twin Platform in accordance with this section, section 013300 and Annexes.

6. Organize CAD information into separate electronic files that correspond to each sheet of the Record Prints. Produce "List of Drawings" sheet. Name each file with the sheet identification number. Include identification in each CAD file. All as follows:

    a. All As-Built drawings and GIS files to be submitted coordinate system as agreed with the Engineer.
    b. The master map unit for As-Built drawings and GIS files should be in meter (m) only.
    c. All As-Built CAD drawings and GIS files to be submitted in digital formats on CD's media.
    d. As-Built CAD and GIS formats are both required for any As-Built design / entity submission.
    e. All As-Built GIS maps to be submitted in standard shape files.
    f. All As-Built CAD drawings should be submitted in original AutoCAD format, (not converted), unless agreed otherwise with the Engineer.
    g. Pen width details for plotting should also be provided in each drawing. (Outside the drawing area).
    h. All reference files (if used) should be copied in a directory called 'reference'.
    i. If any of the files/drawings are using fonts other than the normal fonts provided by the software, then those fonts shall also be copied in a separate directory called 'fonts.
    j. Drawing should be neat and perfect. None of the items shall be outside the drawing sheet area.
    k. Drawings of different disciplines (i.e. Architectural, Structural, Electrical, Mechanical etc.) shall be kept in separate directories with suitable names.
    l. One file shall contain only one drawing.
    m. Drawing shall be drawn/organized in suitable/proper layers/levels. Same kind of items shall always be in the same layer/level.
    n. Drawing shall be copied into CD's in such a way that, when one drawing is opened from the CD, it must be complete and all reference files, fonts & libraries (if used) should attach automatically.
    o. The index of drawings shall also be provided in the original format of the drawing (DGN or DWG) and it must be kept in a directory called "general".
    p. Total number of As-Built drawings in the index and in the CD shall be the same.

q. Change notice drawings shall be submitted along with all other drawings of that project package in a new CD.
r. All the drawings must be numbered serially (sheet number), starting from 001 (drawing index as sheet no. 001) and must be listed in the drawing index. (Total number of drawings in one project (Package) should be same as the sheet number of the last drawing).
s. One (1) file shall contain only one drawing. (This point is also incorporated under item 2.1. F.2 above).
t. All the drawings, sketches or diagrams inside the O&M manuals shall also be stamped as As-Built and certified by the contractor and consultant.
u. All As-Built drawings and GIS files to be submitted in coordinate system to be agreed with the Engineer.
v. All As-Built CAD drawings and GIS files to be submitted in digital formats on CD's media.
w. As-Built CAD and GIS formats are both required for any As-Built design / entity submission.
x. All As-Built GIS maps to be submitted in standard shape files.

1.5 RECORD SPECIFICATIONS

A. Preparation: Mark Specifications to indicate the actual product installation, where installation varies from that indicated in Specifications, addenda, and Contract modifications.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.

2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
3. Record the name of manufacturer, supplier, Installer, and other information necessary to provide a record of selections made.

4. For each principal product, indicate whether Record Product Data has been submitted in operation and maintenance manuals instead of submitted as Record Product Data.
5. Note related Change Orders, Record Product Data, and Record Drawings where applicable.
6. Reflect the Specification information on the BIM Model(s) ready for integration with Digital Twin Platform on a continuous basis.

B. Format: Submit record specifications as annotated PDF electronic file.

1.6 RECORD PRODUCT DATA

A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and revisions to Project Record Documents as they occur; do not wait until the end of Project.

B. Preparation: Mark Product Data to indicate the actual product installation where installation varies substantially from that indicated in Product Data submittal.

1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
2. Include significant changes in the product delivered to Project site and changes in manufacturer's written instructions for installation.
3. Note related Change Orders, Record Specifications, and Record Drawings where applicable.

C. Format: Submit Record Product Data as annotated PDF electronic file.

1. Include Record Product Data directory organized by Specification Section number and title, electronically linked to each item of Record Product Data.

2. Reflect the Product Data on the BIM Model(s) ready for integration with Digital Twin Platform on a continuous basis.

1.7 MISCELLANEOUS RECORD SUBMITTALS

A. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittal in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference. Miscellaneous records include, but are not limited to, the following:

1. Field records on excavations and foundations.
2. Field records on underground construction and similar work.
3. Surveys showing locations and elevations of underground lines.
4. Invert elevations of drainage piping.
5. Surveys establishing building lines and levels.
6. Special and authorized measurements.
7. Certifications received in lieu of labels on bulk products.
8. Batch mixing and bulk delivery records.
9. Testing and qualification of tradesmen.
10. Documented qualification of installation firms.
11. Tests and inspections.
12. Inspections and certifications by governing authorities.
13. Final inspection and correction procedures.
14. Any other information / documents which are not included on As-Built Drawings and Operation and Maintenance Manuals.
15. Reflect the miscellaneous record submittals on the BIM Model(s) ready for integration with Digital Twin Platform on a continuous basis.

B. Format: Submit miscellaneous record submittals as PDF electronic file.

1. Include miscellaneous record submittals directory organized by Specification Section number and title, electronically linked to each item of miscellaneous record submittals.

1.8 MAINTENANCE OF RECORD DOCUMENTS

A. Maintenance of Record Documents: Store Record Documents in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for The Engineer's reference during normal working hours.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 017839

SECTION 017843 - TOOLS AND EXTRA STOCK MATERIAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions and other Division 01 Specifications sections, apply to this Section.

1.2 SUMMARY

A. This Section includes administrative and procedural requirements for extra materials, tools, and spare parts.

1.3 RELATED REQUIREMENTS

A. Technical specifications: specific quantities of extra material required by individual Specifications Sections.

1.4 PRODUCTS REQUIRED

A. Provide quantities of extra materials, tools, and spare parts specified in individual Specification Sections in a matrix table, or as recommended by manufacturer or, if not specified as required in addition to quantities required for completion of work.

B. Products to be identical to those installed in work. Include quantities in original purchase from supplier or manufacturer to avoid variations in manufacture.

C. Provide a complete outline list, including specification or drawing references, of tools to be provided under Contract Documents within 60 days of date of Commencement Date. Submit list to the Engineer in editable electronic form (in Microsoft Excel).

D. Provide within 60 days of date of Commencement Date a complete outline list, including specification or drawing references, of all recommended extra materials and spare parts that the end user may purchase directly. Submit list to the Engineer in editable electronic form (in Microsoft Excel).

E. Provide detailed itemized listings of extra materials, tools, and spare parts for approval concurrent with material submission for each section of work. Provide final approved listing to the Engineer in editable electronic form (in Microsoft Excel).

1.5 STORAGE AND MAINTENANCE

A. Temporarily store and protect tools with products to be installed in work, or in another location acceptable to Engineer.

B. When adequate, provide secure storage facilities available at site capable of maintaining conditions required for storage and not required for Contract work or construction material storage tool, may be stored in available space.

C. Maintain tools, in manufacturer's unopened original containers with labels intact and legible until delivery to Engineer.

1.6 DELIVERY

A. Coordinate final delivery of tools, with Engineer prior to Substantial Completion.

B. Deliver, unload, store, and account for specified quantities of tools in presence of Engineer.

C. Engineer will indicate final placement of tools.

D. Obtain written acceptance from Engineer of receipt of specified quantities of tools.

E. For portions of work accepted and occupied by Employer prior to Substantial Completion, deliver proportional quantity of tools, and maintenance materials if requested by Engineer. Record quantities delivered with Engineer.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 017843

SECTION 017900 - DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions and other Division 01 Specifications sections, apply to this Section.

1.2 SUMMARY

A. This section covers the requirements for preparing, administering, and conducting a training program in English for the Employer and its nominated operator (as applicable), maintenance, supervisor, and instructor trainees in operation, maintenance, and computer software programming of the system. Training shall be of sufficient scope and depth to ensure that all operations, maintenance, and computer software trainees who complete the training program will be fully qualified, certified and capable of operating and / or maintaining the system / subsystems as installed under this Contract. The program shall provide the training, orientation, and familiarization necessary to ensure a smooth transition between system installation and operations activities.

B. This Section includes administrative and procedural requirements for instructing the Employer's personnel, including the following:

1. Instruction in operation and maintenance of systems, subsystems, and equipment.
2. Demonstration and training video recordings.
3. Demonstration of operation of systems, subsystems, and equipment.
4. Training in operation and maintenance of systems, subsystems, and equipment.

C. Related Sections:

1. Division 01 Section 013100 "Project Management and Coordination" for submitting coordination drawings and subcontract list and for requirements for web-based Project software.
2. Division 01 Section 014000 "Quality Requirements" for submitting test and inspection reports, and schedule of tests and inspections.
3. Division 01 Section 017823 "Operation and Maintenance Data" for submitting operation and maintenance manuals.
4. Divisions 02 through 34, Technical Specification Sections for specific requirements for demonstration and training for products in those Sections.

D. PDF digital copy and Two (2) copies of submittals required by this Part shall be supplied to the Engineer / the Employer Authorized Representative for review not later than ninety (90) days prior to scheduled start of each formal training course. Thirty (30) days shall be allowed for such review. Training shall be performed only in accordance with such reviewed and approved training program submittals. All training aids proposed for use in the program shall be available for inspection prior to commencement of training. Upon completion of the training program, the training aids, tools, test equipment, training manuals and other materials relating to the program shall be handed over to the Employer.

E. When short familiarization courses are offered to the Contractor by the equipment manufacturer / vendor as a common industry practice at no extra cost to the Contractor, then the Contractor shall decide for the Employer nominated staff to attend such courses at no additional cost to the Employer

1.3 INFORMATIONAL SUBMITTALS

A. Instruction Program: Submit for the Engineer's approval, outline of instructional program for demonstration and training, including a list of training modules and a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.

1. Indicate proposed training modules using manufacturer-produced demonstration and training video recordings for systems, equipment, and products in lieu of video recording of live instructional module.
2. Include for providing instruction at start of each season for equipment that requires seasonal operation and maintenance.

B. Qualification Data: For facilitator/instructor/videographer.

C. Attendance Record: For each training module, submit a list of participants and length of instruction time.

D. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.

E. A training program stating all program courses and activities, and their individual duration, sequence, and interrelationships.

F. A narrative description of each course, including its purpose, technical scope, and the number of hours from start of course to trainee certification.

G. Current résumés of training and technical personnel who will be assigned to the classroom and / or on-the-job (hands-on) phases of training. Résumés shall be identified by course.

H. The ratio of training and technical personnel to trainees for both classroom and on-the-job phases of each course.

I. A narrative (verbal) and graphic (pictorial) explanation of the system's operational scheme and features that will be covered in the operations-related courses.

J. A narrative (verbal) and graphic (pictorial) explanation of the system's operational and maintenance schemes that will be covered in the maintenance-related courses.

K. A comprehensive training manual for each course in the form and content that will be used in both classroom and on-the-job phases of training. In addition to other information, the manual shall contain an agenda, the hours devoted to each topic / subject, and the objectives for each lesson. Such manual shall be prepared in English.

L. A descriptive listing, by course, of all training aids to be used during both classroom and on-the-job phases of training.

M. A narrative description of the practices to be followed to measure, record, and report each trainee's progress and proficiency on completion of formal training. Also, a description of the method(s) to be used to certify trainees as being capable to operate and/or maintain the system/subsystem.

N. Samples of written examinations to be used for each course.

O. A narrative description of the methods proposed to provide make-up instruction for trainees who miss training sessions due to illness or approved absences.

P. A bibliography containing a listing of reference publications to be used in conjunction with classroom and on-the-job training.

1.4 EMPLOYER-NOMINATED STAFF

A. Employer will nominate staff to receive training. Such trainees may be expected to be familiar with the fundamental concepts of the operation and maintenance of similar systems and be basically qualified in both written and spoken English. Each trainee will be designated by the Employer in one of the three categories (trainee, supervisor-trainee, or instructor-trainee) for operations, maintenance, or computer software training.

1.5 ASSISTANCE TO KEY TECHNICAL PERSONNEL

A. All key technical personnel of the Contractor shall have a general responsibility to assist Employer-nominated trainees in conducting training for the operations and maintenance of the

system/subsystem and equipment. Such assistance shall be a part of their duties and shall be included in their job descriptions.

1.6 QUALIFICATIONS OF TRAINING PERSONNEL

A. Personnel designated to conduct training shall be fully qualified and shall have a minimum of three years' experience with the system/ subsystems as installed, or comparable successful experience as a trainer.

1.7 CLOSEOUT SUBMITTALS

A. Demonstration and Training Video Recordings: Submit two (2) copies within seven (7) days of end of each training module.

1. Identification: On each copy, provide an applied label with the following information:

    a. Name of Project.
    b. Name and address of videographer.
    c. Name of the Engineer.
    d. Name of Construction Manager.
    e. Name of Contractor.
    f. Date of video recording.

2. Transcript: Prepared and bound in format matching operation and maintenance manuals. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding video recording. Include name of Project and date of video recording on each page.
3. Transcript: Prepared in PDF electronic format. Include a cover sheet with same label information as the corresponding video recording and a table of contents with links to corresponding training components. Include name of Project and date of video recording on each page.
4. At completion of training, submit complete training manual(s) for the Employer's use prepared in same paper and PDF file format required for operation and maintenance manuals specified in Section 017823 "Operation and Maintenance Data".

1.8 QUALITY ASSURANCE

A. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
B. Instructor Qualifications: A factory-authorized service representative, complying with requirements in Section 014000 "Quality Requirements," experienced in operation and maintenance procedures and training.
C. Videographer Qualifications: A professional videographer who is experienced photographing demonstration and training events similar to those required.
D. Pre-instruction Conference: Conduct conference at Project site to comply with requirements in Section 013100 "Project Management and Coordination." Review methods and procedures related to demonstration and training including, but not limited to, the following:

1. Inspect and discuss locations and other facilities required for instruction.
2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, audiovisual equipment, and facilities needed to avoid delays.
3. Review required content of instruction.
4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

1.9 COORDINATION

A. Coordinate instruction schedule with the Employer's operations. Adjust schedule as required to minimize disrupting the Employer's operations and to ensure availability of the Employer's personnel.
B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data have been reviewed and approved by the Engineer.

1.10 INSTRUCTION PROGRAM

A. Scope: Training shall be in sufficient scope to ensure that all trainees who complete the program will be certified as capable to operate and / or maintain the equipment, systems, and facilities furnished and installed under this contract, and to ensure a smooth transition between construction and operation activities.
B. Language: Training shall be conducted in English.
C. Program Structure: Develop an instruction program that includes individual training modules for each system and for equipment not part of a system, as required by individual Specification Sections and include by no way of limitation for the following (where applicable):

1. Motorized doors, including overhead coiling doors, overhead coiling grilles and automatic entrance doors.
2. Equipment, including stage equipment, projection screens, loading dock equipment, waste compactors, food-service equipment, and fume hoods.
3. Fire-protection systems, including fire alarm, fire pumps and fire-extinguishing systems.
4. Intrusion detection systems.
5. Conveying systems, including elevators, lifts, escalators, chutes and cranes.
6. Airport networks, CUTE, baggage handling system, AODB, and FIDS.
7. Heat generation, including boilers, feedwater equipment, pumps, steam distribution piping and water distribution piping.
8. Refrigeration systems, including chillers, cooling towers, condensers, pumps and distribution piping.
9. HVAC systems, including fan coils, air-handling equipment, air distribution systems and terminal equipment and devices.
10. HVAC instrumentation and controls management and control system.
11. Electrical service and distribution, including transformers, switchboards, panelboards, uninterruptible power supplies and motor controls.
12. Packaged engine generators, including transfer switches.
13. Lighting equipment and controls.
14. Communication systems, including intercommunication equipment, surveillance, clocks and programming, voice and data and television equipment.

D. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:

1. Basis of System Design, Operational Requirements, and Criteria: Include the following:

a. System, subsystem, and equipment descriptions.
b. Performance and design criteria if Contractor are delegated design responsibility.
c. Operating standards.
d. Regulatory requirements.
e. Equipment function.
f. Operating characteristics.
g. Limiting conditions.

h. Performance curves.

2. Documentation: Review the following items in detail:

   a. Emergency manuals.
   b. Systems and equipment operation manuals.
   c. Systems and equipment maintenance manuals.
   d. Product maintenance manuals.
   e. Project Record Documents.
   f. Identification systems.
   g. Warranties and bonds.
   h. Maintenance service agreements and similar continuing commitments.

3. Emergencies: Include the following, as applicable:

   a. Instructions on meaning of warnings, trouble indications, and error messages.
   b. Instructions on stopping.
   c. Shutdown instructions for each type of emergency.
   d. Operating instructions for conditions outside of normal operating limits.
   e. Sequences for electric or electronic systems.
   f. Special operating instructions and procedures.

4. Operations: Include the following, as applicable:

   a. Startup procedures.
   b. Equipment or system break-in procedures.
   c. Routine and normal operating instructions.
   d. Regulation and control procedures.
   e. Control sequences.
   f. Safety procedures.
   g. Instructions on stopping.
   h. Normal shutdown instructions.
   i. Operating procedures for emergencies.
   j. Operating procedures for system, subsystem, or equipment failure.
   k. Seasonal and weekend operating instructions.
   l. Required sequences for electric or electronic systems.
   m. Special operating instructions and procedures.

5. Adjustments: Include the following:

   a. Alignments.
   b. Checking adjustments.
   c. Noise and vibration adjustments.
   d. Economy and efficiency adjustments.

6. Troubleshooting: Include the following:

   a. Diagnostic instructions.
   b. Test and inspection procedures.

7. Maintenance: Include the following:

   a. Inspection procedures.
   b. Types of cleaning agents to be used and methods of cleaning.
   c. List of cleaning agents and methods of cleaning detrimental to product.
   d. Procedures for routine cleaning.
   e. Procedures for preventive maintenance.
   f. Procedures for routine maintenance.
   g. Instruction on use of special tools.

8. Repairs: Include the following:

    a. Diagnosis instructions.
    b. Repair instructions.
    c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
    d. Instructions for identifying parts and components.
    e. Review of spare parts needed for operation and maintenance.

1.11 TRAINING AIDS

A. Training aids shall include approved operation and maintenance (O&M) manual(s) prepared by the Contractor as part of this Contract; training manuals, including course outline, basic text of instructions modules, and trainee workbook; films; slides; video tape(s); charts; models; hand-outs; catalogues; samples; and other visual and written aids to complement instruction. In addition, spare parts and other special hardware shall be provided to support "hands-on" familiarization with the equipment or systems.

1.12 TRAINING MANUALS

A. Training manuals in English shall be provided for each training course covering both the classroom and on-the-job phases. The organization of the manuals shall follow the same sequence as the course's scheduled presentation of material, providing such additional background and supplementary information as a trainee may need to understand the O&M manuals. The training manuals shall contain course agenda, schedule of hours devoted to each topic or subject, and objectives for each lesson.

1.13 DISPOSITION

A. Upon completion of the training program, all training aids, test equipment, and similar items provided by the Contractor for this training program shall become the property of the Employer.

1.14 PREPARATION

A. Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a training manual organized in coordination with requirements in Section 017823 "Operation and Maintenance Data."
B. Set up instructional equipment at instruction location.
C. Scheduling: Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

    a. Schedule training with the Employer, through the Engineer, with at least seven days' advance notice.

D. SCOPE:

    1. Training shall be performed in accordance with an approved training program. All training aids shall be available and approved prior to start of training.
    2. Each training course shall usually include classroom (theoretical) training and on-the-object (hands-on) training to provide practical experience. Where system/subsystem interfaces occur, such as with equipment or facilities furnished under other contracts, the Contractor shall cooperate with and assist the Employer / the Engineer in coordinating timing and scheduling of training so that trainees can be made familiar with the operation and maintenance of the system subsystem as a complete, in-place, operating unit.

3. Laboratory equipment, spare parts, and mock-up models may be used for theoretical orientation. However, practical "hands-on" familiarization shall be provided on equipment that is either installed and operable or ready to be installed and capable of being operated. System spares of special hardware items may be used to support "hands-on" familiarization as long as said spares are returned to inventory in satisfactory condition in accordance with approved procedures.

E. Proficiency: At designated intervals, each trainee's proficiency level shall be determined by written, oral, and practical performance tests.

F. Completion: Upon satisfactory completion of the training, it shall be certified, in writing, that each trainee, by name, is qualified to operate or maintain the system, supervise or instruct, as applicable.

G. Make-up Instruction: Make-up instruction shall be scheduled to accommodate shift work and authorized absences.

H. Training Categories: Training shall be provided using approved programs in the following categories:

1. Operations.
2. Maintenance.
3. Computer Software.
4. Operations – Supervisor.
5. Operations – Instructor.
6. Maintenance – Supervisor.
7. Maintenance – Instructor.
8. Other Categories as may be required by the Contractor's system design.

I. Operations Training: Operators shall be provided with a thorough training in all aspects of system/subsystem operation under both normal and abnormal conditions. This training shall include, but not be limited to:

1. Orientation to provide overview of system/subsystem purpose, configuration, and operations.
2. Terminology.
3. Operations theory and interface.
4. Equipment appearance, functions, concepts and operation.
5. Operating modes, practices, and procedures under normal and emergency conditions.
6. Safety precautions.
7. On-the-job operating experience covering all system/subsystem operating functions, activities, and tasks including those associated with degraded operating modes; failure recognition, and recovery processes.
8. Familiarity with the content and use of O&M manuals and related reference publications.

J. Maintenance Training: Maintenance training shall cover all on-site routine preventive, and remedial maintenance of the system/subsystem. This training shall include, but not be limited to:

1. Orientation to provide overview of system/subsystem purpose, configuration, and operations.
2. Terminology.
3. Operations theory and interfaces.
4. Equipment appearance, layout, functions, concepts and operations.
5. Operating modes, practices, and procedures under normal and emergency conditions.
6. Safety precautions.
7. Use of tools and test equipment.
8. Preventive maintenance.
9. Troubleshooting, diagnostic, and testing.
10. Assembly and disassembly.
11. Repair and parts replacement.
12. Parts ordering practices and storage.
13. Failure and recovery procedures.
14. System/subsystem cabling.

15. Familiarity with and use of O&M manuals and other reference materials.

K. Computer Software Training: Computer software training shall cover the use, management, development, and maintenance of system/subsystem software. This training shall include, but not be limited to:

1. Orientation to provide overview of system/subsystem concepts, configurations, and operation.
2. Basis programming and software architecture.
3. System executive and utility program.
4. Application program.
5. Modification of command lines codes.
6. Interrupt logic.
7. Intra-and inter system interfaces.
8. Processor system operating procedures.
9. Diagnostics.
10. Communications software.
11. File management.
12. Hands-on training.
13. Safety precautions.
14. Familiarization with and use of O&M manuals and other reference materials.

L. Operations-Supervisor Training: Supplemental and specialized training shall be provided for supervisor level trainees. This training shall impart the knowledge and skills necessary to schedule, supervise, and improve the proficiency of operating and computer software personnel.

M. Operations - Instructor Training: Supplemental and specialized training shall be provided to prepare graduate trainees or nominated instructors successfully to instruct future trainees in system/subsystem operations and computer software.

N. Maintenance - Supervisor Training: Supplemental and specialized training shall be provided for supervisory level trainees. This training shall impart the knowledge and skills necessary to schedule, supervise, and improve the proficiency of maintenance personnel.

O. Maintenance - Instructor Training: Supplemental and specialized training shall be provided to prepare graduate trainees or nominated instructors successfully to instruct future trainees in all phases of system/subsystem maintenance.

P. Cleanup: Collect used and leftover educational materials and remove from instruction location. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

1.15 INSTRUCTION

A. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and the Employer for number of participants, instruction times, and location.

B. Engage qualified instructors to instruct the Employer's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

1. The Engineer will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
2. The Employer will furnish an instructor to describe the Employer's operational philosophy.
3. The Employer will furnish Contractor with names and positions of participants.

C. Scheduling: Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

1. Schedule training with the Employer with at least seven (7) days' advance notice.

D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.
E. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of a verbal and written performance-based test.
F. Cleanup: Collect used and leftover educational materials and remove from Project site. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.

1.16 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

A. General: Engage a qualified commercial videographer to record demonstration and training video recordings. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.

1. At beginning of each training module, record each chart containing learning objective and lesson outline.

B. Digital Video Recordings: Provide high-resolution, digital video in MPEG format, produced by a digital camera with minimum sensor resolution of twelve (12) megapixels and capable of recording in full HD mode with vibration reduction technology.

1. Submit video recordings on CD-ROM or thumb drive by uploading to web-based Project software site.
2. File Hierarchy: Organize folder structure and file locations according to Project Manual table of contents. Provide complete screen-based menu.
3. File Names: Utilize file names based on name of equipment generally described in video segment, as identified in Project specifications.
4. Contractor and Installer Contact File: Using appropriate software, create a file for inclusion on the equipment demonstration and training recording that describes the following for each Contractor involved on the Project, arranged according to Project Manual table of contents:

    a. Name of Contractor / Installer.
    b. Business address.
    c. Business phone number.
    d. Point of contact.
    e. Email address.

C. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to adequately cover area of demonstration and training. Display continuous running time.

1. Film training session(s) in segments not to exceed fifteen 15 minutes.

    a. Produce segments to present a single significant piece of equipment per segment.
    b. Organize segments with multiple pieces of equipment to follow order of Project Manual table of contents.
    c. Where a training session on a particular piece of equipment exceeds 15 minutes, stop filming and pause training session. Begin training session again upon commencement of new filming segment.

D. Light Levels: Verify light levels are adequate to properly light equipment. Verify equipment markings are clearly visible prior to recording.

1. Furnish additional portable lighting as required.

E. Narration: Describe scenes on video recording by audio narration by microphone while dubbing audio narration off-site after video recording is recorded. Include description of items being viewed.

F. Transcript: Provide a transcript of the narration. Display images and running time captured from videotape opposite the corresponding narration segment.
G. Preproduced Video Recordings: Provide video recordings used as a component of training modules in same format as recordings of live training.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 017900

SECTION 017905 - CONSTRUCTION ENVIRONMENTAL MANAGEMENT GUIDELINES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions and other Division 01 Specifications sections, apply to this Section.

1.2 PURPOSE OF DOCUMENT

A. The following General Guidelines are prepared to assist the Contractor undertake their construction activities in a manner that will least damage the environment and cause least disruption to local communities.

B. These Guidelines represent good practice that may be followed by the Contractor. They are based on current construction practices but should not be seen as limiting to the Contractor.

C. This Section shall be read in conjunction with the general provisions of the Contract, including General and Particular Conditions, Construction Environmental Management Plan (CEMP), and applicable relevant accredited international standards and specifications latest version.

1.3 RESPONSIBILITIES

A. The Contractor shall be responsible for full compliance with these Guidelines.

B. The Contractor and his sub-contractors shall be audited and / or asked to provide information at any time during the construction phase by the Engineer or by the Environmental Consultant.

C. These Guidelines do not negate or contradict the responsibility of the Contractor to comply with the provisions of the Construction Environmental Management Plan (CEMP) if exist in full and any environmental protection measures of relevant accredited international standards and specifications latest version and local regulations.

D. There are several acts, statutes and regulations that govern aspects of likely Contractor activity and No Objection certification may be required from various agencies. Many of these agencies are mentioned in the Guidelines. However, the responsibility for obtaining all approvals rests with the Contractor.

E. In considering this, the Contractor must be aware, and confirm in writing, that he shall abide by the Guideline at his sole risk.

F. Electronic copy of documents containing approved plans or permits shall be stored on the specified the Employer Project web site and be available for reference at all times.

G. The Contractor shall maintain a register of all complaints and shall provide electronic copy of these records to the Employer in their monthly report.

H. The Contractor shall identify personnel responsible for implementation, monitoring and updating of any Management Plans required by these Guidelines.

1.4 GUIDANCE AND TRAINING OF PERSONNEL

A. The Contractor must ensure that all their workers and employees are adequately inducted and are well aware of the requirements of relevant accredited international standards and specifications latest version and local regulations and requirements Standards the Construction Environmental Management Guidelines (CEMG) if exists and other legal requirements. It will be the individual responsibility of each worker and employee to ensure their activities and actions do not cause pollution to either the terrestrial or aquatic environments.

B. The Contractor and his sub-contractors must also ensure their workers are made aware of any known or possible activities that could potentially be hazardous to the environment, and they are required to arrange adequate training and instruction for all site personnel in the procedures to be followed to avoid such hazards.

C. The Contractor and his sub-contractors are required to have in place a Health, Safety, Security, Environment, and Social Welfare Plan acceptable to the Employer.

D. Toolbox talks shall be done prior to the task being carried out so as to ensure each team member is fully aware of their responsibilities. Training topics that shall be addressed during toolbox talks include the emergency response procedures and use of spill prevention and clean-up kits, asbestos management, implementation of specific environmental safeguard measures and cultural change towards environment.

1.5 USE OF ENVIRONMENTALLY FRIENDLY AND SAFE MATERIALS

A. All materials used on the sites must be permitted for use and considered to be “environmentally friendly” and safe; for example, lead-free paints and asbestos-free materials are to be used instead of paints and materials that contain these toxic substances.

B. Contractor and his sub-contractors have a duty to proactively seek safer and more environmentally friendly alternatives for all materials currently being used.

1.6 CONSTRUCTION ACTIVITIES

A. The Contractor shall comply with relevant construction requirements and environmental legislation. It will be the responsibility of the Contractor to initiate procedures to prevent pollution, which could arise from Contractor operations and endeavor to reduce the impact upon the environment through continuous improvement in performance.

B. All construction works are to be carried out in such a way so as to minimize disturbance to the environment. In particular, construction work shall be carried out in such a manner that there is no damage to or interference with the following other than to the extent that is necessary for them to be removed or diverted to permit the execution of the Works within the defined operational perimeter:

1. Drainage systems.
2. Public utilities.
3. Structures, roads, or other property; and,
4. Public and private vehicular and pedestrian access.

C. Any facilities disturbed or damaged directly or indirectly due to construction operations shall be restored to their original condition. The Contractor shall discuss his restoration plans with the Employers concerned prior to the start of restoration work to obtain the agreement of the Employers concerned.

D. Appropriate measures shall be implemented during earthworks, stockpiling, concreting, bitumen application and other construction works to suppress dust, prevent toxic fumes and abate noise.

E. The Contractor shall maintain and clean all working areas and temporary buildings on a regular basis and shall at all times keep access to work sites free of all debris, waste and excavated material and other obstructions.

F. The Contractor shall post at least one sign no smaller than 2m2 in a prominent position at all active construction sites that give the name and telephone numbers or e-mail address of the appropriate representative of the Contractor the public may contact to complain about construction activities.

1.7 CONSTRUCTION EQUIPMENT

A. All equipment shall be well maintained, certified (where required) and in good working condition at all times to ensure safe operation with minimal emissions and operational noise. Emission and noise limitation devices installed by the manufacturer shall be maintained and serviced or replaced at intervals not greater than that recommended by the manufacturer.

B. Equipment should be operated only by trained and experienced operators, in an efficient manner, in accordance with the manufacturers' instructions. A register of all persons trained to operate the specialist equipment types similar to that shown in Annex 1 shall be maintained on site.

C. Carrying out repairs (whether minor or major) on alongside roads or on open ground is prohibited. Broken-down vehicles/equipment shall be moved to the workshop for repair or servicing.

D. Routine servicing such as on-the-job addition of oil, lubrication and refueling shall be done with utmost care at designated locations. Designated locations shall be prepared such that the potential adverse effects of accidental hydrocarbon spills are minimized.

E. Post operation cleaning of all machines and heavy equipment such as concrete mixers, truck washing, etc. shall be carried out within a specified washing area that is bunded and paved to prevent ground or aquatic pollution.

F. Portable devices for the measurement of noise and exhaust emissions will be provided by Contractor to the approval of the Engineer.

1.8 POLLUTION

A. Prevention of Water Pollution

1. Construction activities shall be performed by methods that will prevent the entrance or accidental spillage of solid matter, contaminants, debris, and other objectionable pollutants and wastes into the underground aquifer or surface water courses. Such pollutants and wastes include, but are not limited to refuse, cement, concrete, industrial wastes and aggregate tailings.
2. No domestic wastewater may be directly discharged onto or into the ground. The Contractor shall consult with the Employer and agree on the nature, nature and location of any temporary on-site cleansing facilities. Once this has been agreed the contractor shall submit provide a program for wastewater collection and disposal to the Employer for approval.
3. In approving these programmed, the Employer shall ensure that:

    a. The locations of facilities are such as to minimize the risk of direct discharge of wastewaters into shallow aquifers.
    b. Any equipment used for collection and disposal is 'fit-for-purpose'; and,
    c. Operators of such equipment are appropriately trained in its use and are suitably protected against public health and other risks.
    d. Any industrial wastewater generated on site shall be disposed of in accordance with the requirements of the Authorities.

B. Prevention of Soil Pollution

1. The Contractor is required to perform all construction activities by methods that will prevent contamination of the soil by accidental spillage of solid matter, contaminants, debris, and other objectionable pollutants.
2. Minor spills shall be cleaned up immediately in compliance with appropriate MSDS (Materials Storage Details Sheet) and recommended clean up procedures.

C. Remediation

1. If a significant spillage does occur the Contractor will remove all contaminated soil to a site specified by the Employer for disposal and where necessary appropriate replacement material shall be laid. Remediation costs will be borne by the Contractor.

1.9 SITE BOUNDARY

A. The Contractor shall confine activities to site boundaries agreed with the Employer. This applies to all activities including site offices, labor accommodation (where permitted), workshops, warehouses, equipment storage and operation, vehicle parking and associated Contractor's facilities, except and unless agreed with the Employer.

B. All site boundaries shall be clearly identified with the use of either temporary walls or other marking systems approved by the Engineer.

1.10 PUBLIC SERVICES AND UTILITIES

1. Prior to any excavation or performance of any other work directly or indirectly affecting any utility (underground, overhead or on the surface), written authorization shall be obtained from the utility Employer and provider. All works carried out shall conform to utility Employer's and providers' requirements.
2. After co-ordination with the utility agencies, field checks of utility data, including the obtaining of additional data as necessary, shall be undertaken, and before starting work Utilities Work Plans shall be prepared by the Contractor. These Plans will address:

    a. Utilities proposed for temporary support in-place and subsequent restoration.
    b. Temporary relocation with subsequent permanent restoration in-place with the removal or abandonment of the temporary facility.
    c. Permanent relocation with existing facility to be removed or abandoned in-place.
    d. Measures to ensure continuity of operation of the affected utilities in a safe manner.
    e. Procedures to maintain the affected utilities to ensure safety and unhindered function of each utility.
    f. Whether the work will be performed by the utility authority or the Contractor.
    g. Traffic diversion plans and schedules if the utilities to be diverted are within streets.

3. During construction works the utility authorities must be informed of:

    a. Damage to any utility.
    b. Leakage from any utility.
    c. Discovery of utilities not previously identified; and,
    d. Diversion, removal, repositioning, re-erection of utilities that may be required to enable work to proceed.

1.11 WATER SUPPLY AND USE

A. The Contractor shall prepare a Water Plan. This Plan shall contain at minimum:

1. Details of the water source and storage.

2. The method of abstraction.
3. The method of distribution.
4. The provision of access to abstraction points; and,
5. The quantity of permitted extraction, and where relevant, the timing of permitted extraction.

B. If the Contractor exceeds the estimated annual daily average water consumption contained in the Water Plan over any one calendar year, he shall be required to do at least one of the following:

1. Reduce water consumption.
2. Apply for an increase in water allocation; and/or,
3. Seek other sources of water.

1.12 PUBLIC HYGIENE AND SANITARY FACILITIES

A. The Contractor shall supply adequate sanitary facilities to all site(s) including restrooms, showers, water tanks, cold drinking water facilities and solid waste collection systems.

B. All proposed liquid sanitary facilities shall be in accordance with relevant accredited international standards and specifications latest version and local regulations and approved by the Engineer. If a separate system is required, it shall collect all wastewater generated and drain it to a centralized and containerized collection system (septic tanks or similar). Routine checks shall be made to ensure zero leakage from the system.

C. It is not permitted to channel wastewater through a drain to underground or open water bodies.

D. It is not permitted to use open ground for sanitary purposes, including bathing, defecation, urination, cooking, washing dishes or other items, laundry, or other activities that may pose a risk to human health and local ecosystems.

1.13 WASTE MANAGEMENT

A. The Contractor is required to develop a Waste Management Plan (WMP). This will apply to all sites and will be submitted to the Engineer for approval.

B. The Contractor shall at all times keep construction areas, repair shops, storage sites and other areas under his control free from the accumulation of waste material, construction debris and rubbish. Littering of any site in any form, volume or location is prohibited.

C. Suitable dedicated areas with easy access for vehicles shall be allocated for the storage of construction debris/solid waste material prior to disposal. Suitable skips/garbage bins shall be provided on site to enable proper collection.

D. It shall be the responsibility of the Contractor to arrange for the timely collection of sewage and solid waste from the site.

E. It is prohibited to dispose of waste at any site not defined in the approved WMP. Burning of any waste is strictly forbidden.

F. Works that involve onsite filling with material other than virgin excavated natural material require prior approval by the Engineer.

1.14 CONSTRUCTION TRAFFIC

A. The Contractor shall prepare an Access Management Plan (AMP) for approval by the Engineer.

1.15 NON-HAZARDOUS MATERIALS STORAGE

A. Wherever possible, the Contractor shall ensure that all Aggregate, Fill and Spoil Heaps shall be of a size and stability that will ensure the risk of mass movement in periods of rainfall is minimized. To this end the Contractor shall ensure that all such heaps are located at sites that:

1. Do not permit direct run off into water courses.
2. Are generally on flat land, slopes as per relevant international standards and specifications latest version and local regulations.

B. The on-site storage of excessive quantities of such materials should also be avoided.

C. Spill clean-up procedures must be clearly displayed in all material storage areas, with nominated, trained personnel responsible for equipment maintenance and use. All equipment necessary to enact defined clean up measures must be in place at each site, and regularly inspected and tested to ensure it remains operational.

1.16 HAZARDOUS MATERIALS STORAGE AND USE

A. Prior to the commencement of construction, the Contractor shall provide the Engineer with an Initial Materials Inventory (IMI) that will list ALL materials to be stored at each site. This will be accompanied by a Materials Storage Details Sheet

B. (MSDS) for each material, together with details of the proposed storage location and description of the storage facility for each material.

C. The Inventory must specify the purpose/intended use of all hazardous materials that may be stored on site and the quantities required.

D. All hazardous materials shall be used only for their intended and specified purpose and be safely used/installed in strict conformance with the manufacturer's instructions.

E. An up-to-date register of all potentially hazardous materials stored on site must be kept with the Contractor's Environmental Protection Officer. This must include material types, quantities, storage methods, locations and accompanying MSDSs.

F. Clean-up procedures and equipment must be clearly displayed in all hazardous materials storage areas, with nominated, trained personnel responsible for equipment maintenance and use.

G. If during the Contract, the Contractor wishes to store/use a hazardous material that was not listed on the IMI they must seek approval from Engineer prior to the procurement of the material. The request for approval should include the quantity of the material it is proposed to use, a MSDS, the proposed storage location and description of the storage facility.

H. Minor hydrocarbon spills shall be cleaned immediately using appropriate absorbent granules and powders. Flushing of the spill site shall not be permitted until such measures are taken and the majority of the spill is absorbed. Other spills of other substances will be cleaned up in a manner compatible with the MSDS.

I. In the event of a serious spill, and/or contamination, the Contractor shall notify the Engineer immediately and the relevant Emergency Response Plan (ERP) put into action. In this regard any remedial works required to be undertaken by the Contractor or any third party shall be undertaken at the Contractor’s cost. Failure to notify the Engineer of such incidents will be considered a breach of contract.

J. All hazardous waste containers to be labelled clearly with a waste hazard identification label.

K. Hazardous wastes shall be stored in impervious containers for transport by hazardous waste contractors to the appropriate landfill or hazardous waste facility.

1.17 NOISE CONTROL

A. Local Order places responsibility for adopting the 'best practical means of ensuring the emission of noise does not exceed a reasonable level' upon the Employers, occupiers, and supervisors of premises and the drivers of vehicles.

B. The level of noise the LO considers reasonable should be as per relevant accredited [international standards and specifications latest version] [local regulations].

C. Construction equipment will often exceed these levels. However, Contractor shall be expected to limit the nuisance that may be so caused by application the following general noise abatement measures.

1. The Contractor shall maximize the potential for noise attenuation with distance by the placement of noisy plant and machinery away from site boundaries.
2. Advance and regular notification of construction activity schedules shall be provided to potentially affected residents.
3. In the conduct of general construction activities and the operation of other equipment, the Contractor shall utilize all practical methods and devices as are reasonably available to control, prevent and otherwise minimize noise disturbance.
4. The Contractor shall ensure all equipment is properly maintained and shall conform to relevant accredited [international standards and specifications latest version] [local regulations] sound level emissions:
5. The Contractor shall be responsible for monitoring equipment noise levels.

D. Workmen and others present in the vicinity of noise generating sources or operations, particularly those working in trenches or other confined areas, shall be provided with protective devices such as earmuffs.

E. The Contractor shall maintain a telephone line to which members of the public may report noise complaints. The line shall be staffed during all work periods. If any noise level gives rise to public complaints, it shall be treated as a nuisance and the Contractor shall take immediate steps to mitigate the problem.

1.18 AIR QUALITY

A. The Contractor shall comply with relevant accredited international standards and specifications latest version and local regulations.

B. Dust Abatement

1. Throughout the performance of the works the Contractor shall furnish all necessary labor, equipment, materials and means required to carry out effective measures, wherever and as often as necessary, to prevent dust that has originated from his operations causing a nuisance or health hazard to persons.
2. Specific dust suppression measures, may include:
3. The provision of water troughs at site entry and exit points to prevent the carry over, beyond the construction site, of dust emissions.
4. Use of appropriate hoardings.
5. Establishment of speed restrictions for all vehicles operating within the construction site, and/or on access roads to the site.
6. Covering all vehicles transporting materials likely to give off excessive dust emissions.
7. Maintenance of construction site access roads in such a way as to minimize fugitive dust emissions. Water shall be lightly sprayed on exposed ground during dry and windy periods.

8. Adoption of methods of handling cement and pozzolanic that eliminate atmospheric discharges.
9. The Contractor will be held liable for any damages resulting from dust originating from his operations.

C. Other Atmospheric Pollution

1. In operating equipment, the Contractor shall utilize all practical methods and devices as are reasonably available to control, prevent and otherwise minimize atmospheric emissions or the discharge of air contaminants. Equipment and vehicles that show excessive emissions due to poor engine adjustment or other inefficient operating conditions shall be taken out of service and not be deployed again until corrective measures to the satisfaction of the Engineer have been taken.
2. The Contractor shall, where feasible, use clean fuel equipment and emissions control technology for diesel powered engines. Measures to reduce diesel emissions are considered feasible when they are capable of being used on equipment without interfering substantially with equipment performance.
3. Burning of materials resulting from the clearance of trees, bushes and other combustible materials shall not be permitted without the specific approval of the Engineer.

D. Implementing methods of reducing wind speed such as wind barriers in the form of a structure or vegetative barrier, around potentially dusty activities / areas and limiting activities during extremely windy conditions.

1.19 ECOSYSTEMS AND WILDLIFE

A. It shall be strictly forbidden to directly or indirectly cause harm to the fauna (birds, mammals, reptiles) inhabiting the site or their habitats. This does not apply to the removal of recognized pest species by qualified IPC professionals.

B. The Contractor shall impose a total ban on hunting, the capture of species and egg collecting, and on the destruction of habitats through any activity not defined in the contract.

C. All Contractor's staff are to be advised of the requirements above, and of the penalties for non-compliance that will be imposed by the Contractor. In all cases this shall comprise dismissal, and in the event that the actions are deemed to have contravened the relevant adopted accredited [international standards and specifications latest version] [local regulations], prosecution under the relevant law.

D. The penalties to be imposed on staff contravening the requirements of these guidelines shall apply equally to misdemeanors within and outside working hours.

E. The Contractor shall vigorously enforce these penalties.

1.20 TRANSPORT OF CONSTRUCTION WORKFORCE

A. The Contractor is required to ensure that any and all members of the construction workforce legitimately utilizing company vehicles is transported securely and safely.

B. The following provisions are made in this regard:

C. All vehicles used for the transport of staff must be expressly designed for the purpose of transporting people.

D. All drivers of vehicles used for the transport of people must hold a license that permits them to drive that category of vehicle.

E. Any vehicles over 3 years old and used for the transport of staff must be subject to an annual safety inspection.

F. No personal vehicles will be permitted on site without prior approval of the Contractor.

G. No personal vehicle may be used to transport the company workforce on company business.

H. No parking of personal or unauthorized vehicles will be permitted without prior approval of Contractor.

1.21 CULTURAL HERITAGE SITES

A. In undertaking the works the Contractor and his sub-contractors shall be aware, and make all his staff and workers, aware, of the presence of "Listed" archaeological sites within the Site, the location of which shall have been provided during the bidding process.

B. The Contractor shall make provision for the monitoring of ground-breaking activities greater than 40mm in depth at all listed sites and apply a "chance find" procedure at all other times.

C. In the event that previously unidentified cultural resources are discovered, the Contractor shall cease work in the immediate area and report the find to Employer and relevant authorities.

D. In the event that human skeletal remains are encountered, Contractor will be required to immediately notify relevant authority and no further works may continue until clearance to continue has been issued by the relevant authority.

1.22 HEALTH AND SAFETY

A. Identification and provision of appropriate personal protective equipment (PPE), on-going job specific occupational health and safety training and monitoring, as well as ongoing safety checks and safety audits will be conducted.

B. Provision of appropriate first aid and medical supplies and the location and route to the nearest hospitals will be identified and form part of the on-site workforce training.

1.23 POST-CONTRACT ACTIVITIES AND DEMOBILIZATION

A. Upon completion of all works contracts, all project sites shall be cleaned up; all construction debris, waste and surplus material and rubbish shall be removed and the site and other affected areas shall be fully restored.

B. Final approval and hand over of completed construction sites and Contractor demobilization shall be subject to certification of environmental compliance by the Employer. The approval certification shall be based on a field assessment carried out by the Engineer with the Contractor, and potentially other Authorities as required.

C. It may be necessary to carry out a series of remediation activities to mitigate adverse impacts before approval is granted.

1.24 ANNEX 1 REGISTER OF TRAINED OPERATORS

Operator Name	Equipment Authorised to Operate	Training and Operational History	Authorising Authority

END OF SECTION 017905

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SECTION 018113.14 - SUSTAINABLE DESIGN REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings, Bill of Quantities and general provisions of the Contract, including General and Particular Conditions, schedules and other Specification Sections, apply to this Section.

B. Division 01 Section 015000 Temporary Facilities and Controls

C. Division 01 Section 017419 Construction Waste Management

D. Division 01 Section 019113 General Commissioning Requirements

1.2 SUMMARY

A. General considerations:

1. Specific requirements for sustainability are also included in other Sections and should be abided by.

2. Other sustainability requirements depend on product selections. Compliance with requirements needed may be used as one criterion to evaluate substitution requests and comparable product requests.

3. Sustainability criteria checklist:

a. Sustainability requirements needed depend on Engineer's design and other aspects of Project.

b. The Contractor should abide by the minimum Sustainability requirements.

c. The Contractor to abide by any new requirement dictated by the updated Sustainability strategy.

d. Sustainability requirements may be updated in future stages based on design developments or due to any other aspect of the Project.

e. Sustainability requirements must be achieved by the Contractor including the design and construction requirements. Contractor is to review the package received for Tender and acquire all documentations needed for early design from the original designer.

f. When several options are available to achieve the Sustainability requirements, the option to be followed shall be agreed with the Engineer before the start of the work.

4. The commissioning scope should cover all the requirements dictated by Section 019113 “General Commissioning Requirements”.

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1.3 DEFINITIONS

A. Chain of Custody (CoC): a procedure that tracks a product from the point of harvest or extraction to its end use, including all successive stages of processing, transformation, manufacturing, and distribution.

B. Construction Activity Pollution Prevention: To reduce pollution from construction activities by controlling soil erosion, waterway sedimentation, and airborne dust.

C. Cradle-to-gate assessment: Analysis of product's partial life cycle, from resource extraction (cradle) to the factory gate (before it is transported for distribution and sale), it omits the use and the disposal phases of the product.

D. Environmental Product Declaration: A statement that the item meets the environmental requirements of ISO 1402-1999, ISO 14025-2006 and EN 15804 or ISO 21930-2007.

E. Extended Producer Responsibility: Measures undertaken by the maker of a product to accept its own and sometimes other manufacturers' products as postconsumer waste at the end of the products' useful life. Producers recover and recycle the materials for use in new products of the same type. To count toward credit compliance, a program must be widely available. For carpet, extended producer responsibility must be consistent with NSF/ANSI 140–2007. Also known as closed-loop program or product take-back.

F. Life-cycle assessment: An evaluation of the environmental effects of a product from cradle to grave, as defined by ISO14040-2006 and 14044-2006.

G. Raw Material: The basic substance from which products are made, such as concrete, glass, gypsum, masonry, metals, recycled materials (e.g., plastics and metals), oil (petroleum polylactic acid), stone, agrifiber, bamboo, and wood.

H. Recycled Content: The recycled content value of a material assembly shall be determined by weight. The recycled fraction of the assembly is then multiplied by the cost of assembly to determine the recycled content value.

1. Postconsumer recycled content: Waste generated by households or commercial, industrial and institutional facilities in their role as end users of a product that can no longer be used for its intended purpose.
2. Preconsumer recycled content: Matter diverted from the waste stream during the manufacturing process, determined as the percentage of material, by weight. Examples include planer shavings, sawdust, bagasse, walnut shells, culls, trimmed materials, over issue publications, and obsolete inventories. The designation excludes rework, regrind, or scrap materials capable of being reclaimed within the same process that generated them (ISO 14021).

I. Regional Materials: Materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site. If only a fraction of a product or material is extracted/harvested/recovered and manufactured locally, then only that percentage (by weight) shall contribute to the regional value.

J. Reuse: The reemployment of materials in the same or a related capacity as their original application, thus extending the lifetime of materials that would otherwise be discarded. Reuse includes the recovery and reemployment of materials recovered from existing building or construction sites. Also known as salvage.

K. Solar Reflectance Index (SRI): The measure of a constructed surface's ability to stay cool in the sun by reflecting solar radiation and emitting thermal radiation. SRI values range from zero (solid black surface) to 100 (solid white surface). SRI value of a material is calculated according to ASTM E1980 and based on the aged tested values of solar reflectance and thermal emittance.

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L. Wood: Plant-based materials that are eligible for certification under the Forest Stewardship Council. Examples include bamboo and palm (monocots) as well as hardwoods (angiosperms) and softwoods (gymnosperms).

1.4 PREINSTALLATION CONFERENCE:

A. Contractor to conduct conference at site to review Sustainability requirements and action plans to meet the compliance and certification requirements and achieve all construction requirements and materials procurement requirements.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Respond to questions and requests from the Engineer regarding Sustainability requirements that are the responsibility of the Contractor, and which depend on product selection or product qualities, or which depend on Contractor's procedures.

B. Submit documentation to Engineer respond to questions and requests from the Engineer regarding Sustainability requirements that are the responsibility of the Contractor, that depend on product selections or product qualities, or that depend on the Contractor's procedures.

1. Document correspondence as informational submittals.

1.6 ACTION SUBMITTALS

A. General: Submit additional Sustainability submittals required in other Specification Sections.

B. Sustainable design submittals are in addition to other submittals.

1. If submitted item is identical to that submitted to comply with other requirements, include an additional electronic copy with other submittal as a record of compliance with indicated Sustainability requirements instead of separate sustainable design submittal. Mark additional copy "Sustainable design submittal."

C. Sustainable Design Documentation Submittals:

1. Documentation for luminaires indicating BUG ratings, lumens emitted, and vertical illuminance values.
2. Documentation for compliant paving materials indicating the SRI, SR, and permeability.
3. Documentation for compliant roofing materials indicating the SRI.
4. Product Data and certification for Water Sense-labeled water fixtures.
5. Product Data for plumbing fixtures indicating flush or flow rate.
6. Environmental Product Declarations (EPDs) complying with Sustainability requirements.
7. Documentation for products that have a compliant embodied carbon optimization report or action plan separate from the LCA or EPD.
8. Documentation for products that comply with Sustainability requirements for multi-attribute optimization.
    a. Include documentation for regional materials, indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material and costs of regional materials.
    b. Include documentation for any applicable third-party certifications.
9. Sustainability reports for products that comply with Sustainability requirements for raw material and source extraction reporting.

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a. Extended producer responsibility. Products purchased from a manufacturer (producer) that participates in an extended producer responsibility program or is directly responsible for extended producer responsibility. Products meeting extended producer responsibility criteria are valued at 50% of their cost for the purposes of target achievement calculation.
b. Bio-based materials. Bio-based products and materials other than wood must be tested using ASTM Test Method D6866 or equivalent method ISO 16620-2 or be certified to the USDA BioPreferred Voluntary Labeling Initiative that includes verification via ASTM 6866 testing. Exclude hide products, such as leather and other animal skin materials.
    1) Bio-based products that meet the criteria above: value at 50% of cost multiplied by the biobased content of the product for the purposes of target achievement calculation.
c. Wood products. Wood products must be certified by the Forest Stewardship Council or USGBC-approved equivalent. Products meeting wood products criteria are valued at 100% of their cost for the purposes of target achievement calculation.
d. Materials reuse. Reuse includes salvaged, refurbished, or reused products. Products meeting materials reuse criteria are valued at 200% of their cost for the purposes of target achievement calculation.
e. Recycled content. Products meeting recycled content criteria are valued at 100% of their cost for the purposes of target achievement calculation.
    1) Recycled content is the sum of postconsumer recycled content plus one-half the preconsumer recycled content, based on weight.
    2) The recycled fraction of the assembly is then multiplied by the cost of assembly to determine the recycled content value.

10. Documentation for products that comply with Sustainability requirements for leadership extraction practices. Include the following:
    a. Product Data and certification letter from product manufacturers, indicating participation in an extended producer responsibility program and statement of costs.
    b. Product Data and certification for bio-based materials, indicating that they comply with requirements. Include statement of costs.
    c. Product Data and chain-of-custody certificates for products containing certified wood. Include invoices.
    d. Receipts for salvaged and refurbished materials used for Project, indicating sources and costs.
    e. Product Data and certification letter from product manufacturers, indicating percentages by weight of postconsumer and preconsumer recycled content for products having recycled content. Include statement of costs.
    f. Documentation for regional materials, indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material and costs of regional materials.
11. Material ingredient reports for products that comply with Sustainability requirements for material ingredient reporting.
    a. ANSI/BIFMA e3 Furniture Sustainability Standard The documentation from the assessor or scorecard from BIFMA must demonstrate the product earned at least 3 points under 7.5.1.3 Advanced Level in e3-2014 or 3 points under 7.4.1.3 Advanced Level in e3-2012.
    b. Cradle to Cradle. Product has Material Health Certificate or is Cradle to Cradle Certified™ under standard version 3 or later with a Material Health achievement level at the Bronze level or higher
    c. Declare. The Declare product label must meet the following requirements:
    d. Declare labels designated as Red List Free, LBC Red List Free, or Declared.
    e. Declare labels designated as LBC Red List Approved or LBC Compliant that demonstrate content inventory to 0.1% (1,000 ppm).
    f. Facts – NSF/ANSI 336: Sustainability Assessment for Commercial Furnishings Fabric at any certification level.
    g. Global Green TAG. Product Health Declaration (PHD) labels issued after January 1, 2020.

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h. Health Product Declaration. The end use product has a published and complete Health Product Declaration with full disclosure of known hazards in compliance with the Health Product Declaration Open Standard.
i. Living Product Challenge. The included Declare product label must demonstrate content inventory to 0.1% (1,000 ppm).
j. Manufacturer Inventory. The manufacturer has published complete content inventory for the product following these guidelines:
k. A publicly available inventory of all ingredients identified by name and Chemical Abstract Service Registration Number (CASRN) and/or European Community Number (EC Number).
l. Materials defined as trade secret or intellectual property may withhold the name and/or CASRN/EC Number but must disclose ingredient/chemical role, amount and hazard score/class using either:
m. Greenscreen List Translator (LT) score and/or Full GreenScreen Benchmark (BM)
n. The Globally Harmonized System of Classification and Labeling of Chemicals rev.6 (2015) (GHS)
o. Product Lens Certification

12. Documentation for products that comply with Sustainability requirements for material ingredient optimization. (Reach Optimization, Declare, etc.)
13. Documentation for products that comply with Sustainability requirements for product manufacturer supply chain optimization.

    a. Include documentation for regional materials, indicating location and distance from Project of material manufacturer and point of extraction, harvest, or recovery for each raw material and costs of regional materials.

14. Documentation complying with Section 017419 "Construction Waste Management and Disposal."
15. Product Data for adhesives and sealants used inside weatherproofing system, indicating VOC content and laboratory test reports showing compliance with requirements for low-emitting materials.
16. Product Data for paints and coatings used inside weatherproofing system, indicating VOC content and laboratory test reports showing compliance with requirements for low-emitting materials.
17. Laboratory test reports for flooring, indicating compliance with requirements for low-emitting materials.
18. Laboratory test reports for products containing composite wood or Agri fiber products or wood glues, indicating compliance with requirements for low-emitting materials.
19. Laboratory certificates for compliant composite wood products.
20. Laboratory test reports for ceilings, walls, and thermal insulation, indicating compliance with requirements for low-emitting materials.
21. Construction Indoor-Air-Quality (IAQ) Management:

    a. Construction IAQ ESplan.
    b. Product data for temporary filtration media.
    c. Product data for filtration media used during occupancy.
    d. Construction Documentation: Six photographs at three different times during the construction period, along with a brief description of the SMACNA approach employed, documenting implementation of the IAQ management measures, such as protection of ducts and on-site stored or installed absorptive materials.

22. IAQ Assessment:

    a. Signed statement describing the building air flush-out procedures, including the dates when flush-out was begun and completed and statement that filtration media was replaced after flush-out.
    b. Product data for filtration media used during flush-out and occupancy.
    c. Report from testing and inspecting agency indicating results of IAQ testing and documentation showing compliance with IAQ testing procedures and requirements.

23. Construction Activity Pollution Prevention:

    a. Before construction begins, create and submit a construction activity pollution prevention plan that includes dust control plan and erosion and sedimentation control plan for all construction activities associated with the project. The erosion and sedimentation control plan must conform to the related regulations, local orders and their executive orders, technical guidelines, guides and construction safety codes and practices. The plan must describe measures implemented.

24. Laboratory test reports of products complying with heat island reduction requirement including, Solar Reflectance (SR) for Nonroof measures and Solar Reflectance Index (SRI) for Roof measures.
25. Submit all narratives, plans, as-built drawings, plans, elevations, calculators to confirm compliance, quality checked and reviewed to the Engineer.
26. Submit all drawings and calculations
27. Cooling Tower Water Use
    a. Project site's potable water analysis results and non-potable water (if applicable) analysis results. At a minimum, the analysis must measure the following concentration parameters (Ca (as $CaCO_3$), Total alkalinity, SiO_2, Cl^-, Conductivity)
    b. Potable and non-potable water analysis narrative.
    c. Cycle of concentrations calculations and narrative.

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Sustainability coordinator.

B. Project Materials Cost Data: Provide statement indicating total cost for materials used for Project. Costs exclude labor, overhead, and profit. Include breakout of costs for the following categories of items:
   1. Furniture.
   2. Plumbing.
   3. Mechanical.
   4. Electrical.
   5. Specialty items, such as elevators and equipment.

C. Sustainable Design Action Plans: Provide preliminary submittals within 30 days of date established for Commencement of the Works, indicating how the following requirements will be met:

   1. List of proposed products with Environmental Product Declarations.
   2. List of proposed products complying with requirements for multi-attribute optimization.
   3. List of proposed products complying with requirements for raw material and source extraction reporting.
   4. List of proposed products complying with requirements for leadership extraction practices.
   5. List of proposed products complying with requirements for material ingredient reporting.
   6. List of proposed products complying with requirements for material ingredient optimization.
   7. List of proposed products complying with requirements for product manufacturer supply chain optimization.
   8. Waste management plan complying with Section 017419 "Construction Waste Management and Disposal."
   9. Construction IAQ management plan.
   10. List of proposed products complying with requirements for Heat Island Reduction.

D. Sustainable Design Progress Reports: Concurrent with each Application for Payment, submit reports comparing actual construction and purchasing activities with sustainable design action plans.

E. Sustainable Progress Reports (during Construction Stage) to be submitted for Engineer's review at least monthly (or as it will be advised by Engineer).

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1.8 QUALITY ASSURANCE

A. Sustainability Coordinator: Engage an experienced Sustainability Coordinator to coordinate Sustainability requirements, Curriculum Vitae including qualifications and references to Sustainability projects undertaken to be submitted to the Engineer. Sustainability coordinator may also serve as waste management coordinator.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide products and procedures necessary to comply with Sustainability requirements required in this Section. Although other Sections may specify some requirements that contribute to the Sustainability Strategy, the Contractor shall provide additional materials and procedures necessary to comply with the Sustainability requirements.

B. Contractor to provide Environmental Declaration Reporting for different permanently installed products sourced from different manufacturers that meet one of the disclosure criteria below.
   1. Life-cycle assessment and environmental product declarations.
      a. Products with a publicly available, critically reviewed life-cycle assessment conforming to ISO 14044 that have at least a cradle to gate scope are valued as one whole product for the purposes of target achievement calculation.
      b. Product-specific Type III EPD -- Internally Reviewed. Products with an internally critically reviewed LCA in accordance with ISO 14071. Products with product specific internal EPDs which conform to ISO 14025, and EN 15804 or ISO 21930 and have at least a cradle to gate scope are valued as one whole product for the purposes of target achievement calculation.
      c. Industry-wide Type III EPD -- Products with third-party certification (Type III), including external verification, in which the manufacturer is explicitly recognized as a participant by the program operator. Products with industry wide EPDs, which conform to ISO 14025, and EN 15804 or ISO 21930 and have at least a cradle to gate scope are valued as one whole product for the purposes of target achievement calculation.
   2. Environmental Product Declarations which conform to ISO 14025 and EN 15804 or ISO 21930 and have at least a cradle to gate scope.
      a. Product-specific Type III EPD -- Products with third-party certification (Type III), including external verification and external critical review are valued as 1.5 products for the purposes of target achievement calculation.

C. The Contractor shall be required to provide any requested final documents, manufacturer's data, data or product sheets, plans, results, drawings, and / or reports to illustrate proof of implementation.

D. Use products that have a compliant embodied carbon optimization report or action plan separate from the LCA or EPD

E. Contractor to ensure the use of products sourced from different manufacturers that meet at least one of the responsible sourcing and extraction criteria, by cost, of the total value of permanently installed building products in the project.
   a. Extended producer responsibility. Products purchased from a manufacturer (producer) that participates in an extended producer responsibility program or is directly responsible for extended producer responsibility. Products meeting extended producer responsibility criteria are valued at 50% of their cost for the purposes of target achievement calculation.
   b. Bio-based materials. Bio-based products and materials other than wood must be tested using ASTM Test Method D6866 or equivalent method ISO 16620-2 or be certified to the USDA BioPreferred Voluntary Labeling Initiative that includes verification via

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ASTM 6866 testing. Exclude hide products, such as leather and other animal skin materials.

1) Bio-based products that meet the criteria above: value at 50% of cost multiplied by the biobased content of the product for the purposes of target achievement calculation.

c. Wood products. Wood products must be certified by the Forest Stewardship Council or USGBC-approved equivalent. Products meeting wood products criteria are valued at 100% of their cost for the purposes of target achievement calculation.

d. Materials reuse. Reuse includes salvaged, refurbished, or reused products. Products meeting materials reuse criteria are valued at 200% of their cost for the purposes of target achievement calculation.

e. Recycled content. Products meeting recycled content criteria are valued at 100% of their cost for the purposes of target achievement calculation.

1) Recycled content is the sum of postconsumer recycled content plus one-half the preconsumer recycled content, based on weight.

2) The recycled fraction of the assembly is then multiplied by the cost of assembly to determine the recycled content value.

1. Cost of postconsumer recycled content plus one-half of preconsumer recycled content of an item shall be determined by dividing weight of postconsumer recycled content plus one-half of preconsumer recycled content in the item by total weight of the item and multiplying by cost of the item.
2. Do not include plumbing, mechanical and electrical components, and specialty items, such as elevators and equipment, in the calculation.

F. Concrete to be used with Fly ash or GGBS or GGBFS

G. Certified Wood: Not less than 50 percent, by cost, of wood-based materials shall be produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC STD- 01-001.

H. Contractor to ensure the use of different permanently installed products from different manufacturers that use any of the following programs to demonstrate the chemical inventory of the product to at least 0.1% (1,000 ppm).

1. ANSI/BIFMA e3 Furniture Sustainability Standard The documentation from the assessor or scorecard from BIFMA must demonstrate the product earned at least 3 points under 7.5.1.3 Advanced Level in e3-2014 or 3 points under 7.4.1.3 Advanced Level in e3-2012.
2. Cradle to Cradle. Product has Material Health Certificate or is Cradle to Cradle Certified™ under standard version 3 or later with a Material Health achievement level at the Bronze level or higher
3. Declare. The Declare product label must meet the following requirements:
4. Declare labels designated as Red List Free, LBC Red List Free, or Declared.
5. Declare labels designated as LBC Red List Approved or LBC Compliant that demonstrate content inventory to 0.1% (1,000 ppm).
6. Facts – NSF/ANSI 336: Sustainability Assessment for Commercial Furnishings Fabric at any certification level.
7. Global Green TAG. Product Health Declaration (PHD) labels issued after January 1, 2020.
8. Health Product Declaration. The end use product has a published and complete Health Product Declaration with full disclosure of known hazards in compliance with the Health Product Declaration Open Standard.
9. Living Product Challenge. The included Declare product label must demonstrate content inventory to 0.1% (1,000 ppm).
10. Manufacturer Inventory. The manufacturer has published complete content inventory for the product following these guidelines:
11. A publicly available inventory of all ingredients identified by name and Chemical Abstract Service Registration Number (CASRN) and/or European Community Number (EC Number).
12. Materials defined as trade secret or intellectual property may withhold the name and/or CASRN/EC Number but must disclose ingredient/chemical role, amount and hazard score/class using either:

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13. Greenscreen List Translator (LT) score and/or Full GreenScreen Benchmark (BM)
14. The Globally Harmonized System of Classification and Labeling of Chemicals rev.6 (2015) (GHS)
15. Product Lens Certification

I. Contractor to ensure the use of products that have a compliant optimized material ingredient report or action plan. (Declare, REACH Optimization, etc.)

J. All refrigerants, fire suppression systems and maintenance gases installed and used within the project boundary should have an ODP of zero and a low GWP.

K. It is prohibited to use CFCs or halon-based materials through the project.

L. Insulation: All acoustic and thermal insulation must meet the following:
1. Manufactured without the use of chlorofluorocarbons (CFCs) or hydrochlorofluorocarbons (HCFC's). a) Ozone Depletion Potential (ODP) is zero and Global Warming Potential (GWP) is less than 5.
2. Compliance blowing agent used to manufacture the insulation product to spray it in place.
3. Formaldehyde to be max or less than 13.5 parts per billion (ppb).
4. Non-toxic and no release of toxic fumes during combustion.

M. Electrical Vehicle Supply Equipment (EVSE): EVSE shall comply with the following:
1. Provide a Level 2 charging capacity (208 – 240 volts) or greater.
2. Comply with the relevant regional or local standard for electrical connectors, such as:
   a. SAE Surface Vehicle Recommended Practice J1772
   b. SAE Electric Vehicle Conductive Charge Coupler.
   c. IEC 62196 of the International Electrotechnical Commission for projects outside the U.S.

N. At least 50 percent, by Area of the hardscape materials shall have a three-year aged solar reflectance (SR) value of at least 0.28. If three-year aged value information is not available, use materials with an initial SR of at least 0.33 at installation.

O. At least 75 percent, by area of the roofing materials shall have an SRI value equal or greater than the value in the table below. Meet the three-year aged SRI value. If three-year aged value information is not available, use materials that meet the initial SRI value.

Minimum solar reflectance index value, by roof slope			
	Slope	Initial SRI Value	3-year aged SRI Value
Low-sloped roof	≤2:12	82	64
Steep-Sloped roof	>2:12	39	32

P. The Contractor shall comply, abide by and achieve the following:

1. Construction Activity Pollution Prevention.

2. Volatile Organic Compounds (VOC) limits to follow the more stringent requirements between what is noted in the specifications and the local code and achieve the threshold level of compliance with emissions and content standards for the number of product categories already predefined in Sustainability requirements or by using Budget Calculation Method.

3. Construction Indoor Air Quality Management Plan:
   Develop and implement an Indoor Air Quality (IAQ) management plan for the construction and preoccupancy phases of the building. The plan must address all of the following:

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During construction, meet or exceed all applicable recommended control measures of the Sheet Metal and Air Conditioning National Contractors Association (SMACNA) IAQ Guidelines for Occupied Buildings under Construction, 2nd edition, 2007, ANSI/SMACNA 008–2008, and Chapter 3.
Protect absorptive materials stored on-site and installed from moisture damage.
Do not operate permanently installed air-handling equipment during construction unless filtration media with a minimum efficiency reporting value (MERV) of 13, as determined by ASHRAE 52.2–2007, with errata (or equivalent filtration media class of F5 or higher, as defined by CEN Standard EN 779–2002, Particulate Air Filters for General Ventilation, Determination of the Filtration Performance), are installed at each return air grille and return or transfer duct inlet opening such that there is no bypass around the filtration media. Immediately before occupancy, replace all filtration media with the final design filtration media, installed in accordance with the manufacturer's recommendations.
Prohibit the use of tobacco products inside the building and within 25 feet (7.5 meters) of the building entrance during construction.

4. Indoor Air Quality Assessment:
   If occupancy is desired prior to flush-out, maintain an internal temperature of at least 60°F (15°C) and no higher than 80°F (27°C) and relative humidity no higher than 60%.

2.2 LOW-EMITTING MATERIALS

A. The values below are to be compared with the local code. The most stringent is to be adopted.

B. Paints and Coatings: For field applications that are inside the weatherproofing system, paints and coatings shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Flat Paints and Coatings: 30 g/L.
2. Nonflat Paints and Coatings: 50 g/L.
3. Dry-Fog Coatings: 150 g/L.
4. Primers, Sealers, and Undercoaters: 30 g/L.
5. Rust-Preventive Coatings: 100 g/L.
6. Zinc-Rich Industrial Maintenance Primers (solvent based): 100 g/L.
7. Zinc-Rich Industrial Maintenance Primers (water based): 30 g/L
8. Pretreatment Wash Primers: 420 g/L.
9. Clear Wood Finishes, Varnishes (solvent based): 275 g/L.
10. Clear Wood Finishes, Varnishes (water based): 130 g/L.
11. Clear Wood Finishes, Lacquers: 275 g/L.
12. Floor Coatings: 50 g/L.
13. Shellacs, Clear (solvent based): 700 g/L.
14. Shellacs, Clear (water based): 130 g/L
15. Shellacs, Pigmented: 550 g/L.
16. Stains: 100 g/L.

C. Paints and Coatings: For field applications that are inside the weatherproofing system, 90 percent of paints and coatings by volume shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers" V1.1-2010, using the applicable exposure scenario. The manufacturer's or third-party certification must state the exposure scenario used to determine compliance. Manufacturers' claims of compliance must also state the range of total VOCs after 14 days (336 hours) measured as specified in the CDPH standard method v1.1.

For wet applied paints and coatings, in addition to meeting the general requirements for VOC emissions (above), 100 percent of on-site wet-applied paints and coatings must meet the applicable VOC limits of the California Air Resources Board (CARB) 2007, Suggested Control Measure (SCM) for architectural coatings, or the south coast air quality management district (SCAQMD) rule 1113. Claims of compliance for wet-applied products must state the amount applied in mass per surface area.

D. Adhesives and Sealants: For field applications that are inside the weatherproofing system, adhesives and sealants shall comply with VOC content limits of authorities having jurisdiction and the following VOC content limits:

1. Wood Glues: 30 g/L.
2. Metal-to-Metal Adhesives: 30 g/L.
3. Adhesives for Porous Materials (Except Wood): 50 g/L.
4. Subfloor Adhesives: 50 g/L.
5. Plastic Foam Adhesives: 50 g/L.
6. Carpet Adhesives: 50 g/L.
7. Carpet Pad Adhesives: 50 g/L.
8. VCT and Asphalt Tile Adhesives: 50 g/L.
9. Cove Base Adhesives: 50 g/L.
10. Gypsum Board and Panel Adhesives: 50 g/L.
11. Rubber Floor Adhesives: 60 g/L.
12. Ceramic Tile Adhesives: 65 g/L.
13. Multipurpose Construction Adhesives: 70 g/L.
14. Fiberglass Adhesives: 80 g/L.
15. Contact Adhesives: 80 g/L.
16. Structural Glazing Adhesives: 100 g/L.
17. Wood Flooring Adhesives: 100 g/L.
18. Structural Wood Member Adhesives: 140 g/L.
19. Single-Ply Roof Membrane Adhesives: 250 g/L.
20. Special-Purpose Contact Adhesives (That Are Used to Bond Melamine-Covered Board, Metal, Unsupported Vinyl, Rubber, or Wood Veneer 1/16 Inch or Less in Thickness to Any Surface): 250 g/L.
21. Top and Trim Adhesives: 250 g/L.
22. Plastic Cement Welding Compounds: 250 g/L.
23. ABS Welding Compounds: 325 g/L.
24. CPVC Welding Compounds: 490 g/L.
25. PVC Welding Compounds: 510 g/L.
26. Adhesive Primer for Plastic: 550 g/L.
27. Sheet-Applied Rubber Lining Adhesives: 850 g/L.
28. Aerosol Adhesive, General-Purpose Mist Spray: 65 percent by weight.
29. Aerosol Adhesive, General-Purpose Web Spray: 55 percent by weight.
30. Special-Purpose Aerosol Adhesives (All Types): 70 percent by weight.
31. Other Adhesives: 250 g/L.
32. Architectural Sealants: 250 g/L.
33. Nonmembrane Roof Sealants: 300 g/L.
34. Single-Ply Roof Membrane Sealants: 450 g/L.
35. Other Sealants: 420 g/L.
36. Sealant Primers for Nonporous Substrates: 250 g/L.
37. Sealant Primers for Porous Substrates: 775 g/L.
38. Modified Bituminous Sealant Primers: 500 g/L.
39. Other Sealant Primers: 750 g/L.

E. Adhesives and Sealants: For field applications that are inside the weatherproofing system, 90 percent of adhesives and sealants by volume shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers. V1.1-2010, using the applicable exposure scenario. The manufacturer’s or third-party certification must state the exposure

scenario used to determine compliance. Manufacturers' claims of compliance must also state the range of total VOCs after 14 days (336 hours) measured as specified in the CDPH standard method v1.1.

For wet applied adhesives and sealants, in addition to meeting the general requirements for VOC emissions (above), 100 percent of on-site wet-applied adhesives and sealants must meet the applicable chemical content requirements of SCAQMD Rule 1168. Claims of compliance for wet-applied products must state the amount applied in mass per surface area.

F. Flooring: Flooring shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers.

G. Composite Wood: Composite wood, agrifiber products, and adhesives shall be made using ultra-low-emitting formaldehyde resins as defined in the California Air Resources Board's "Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products" or shall be made with no added formaldehyde. Furthermore, Composite wood must be documented not to exceed a concentration limit of 0.05ppm of formaldehyde (0.06mg/m2-h when expressed as emission rate).

H. Ceilings, Walls, Thermal Insulation and Acoustic Insulation: Ceilings, walls, thermal insulation and acoustic insulation shall comply with the requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

I. Suspended Ceiling Systems: All internal suspended ceiling systems must have a maximum formaldehyde limit of 13.5 ppb (or 16.5 µg/m3)

PART 3 - EXECUTION

3.1 NONSMOKING

A. Smoking is not permitted within the building or within 7.5m of entrances, operable windows, or outdoor air intakes.

3.2 CONSTRUCTION WASTE MANAGEMENT

A. Comply with Section 017419 "Construction Waste Management and Disposal."

B. Ensure that at least 75% of construction and demolition waste is managed on site.

3.3 CONSTRUCTION INDOOR-AIR-QUALITY (IAQ) MANAGEMENT

A. Comply with SMACNA's "SMACNA IAQ Guideline for Occupied Buildings under Construction."

1. If Owner authorizes use of permanent heating, cooling, and ventilating systems during construction period as specified in Section 015000 "Temporary Facilities and Controls," install MERV 8 filter media at each return-air inlet for the air-handling system used during construction.
2. Replace air filters immediately prior to occupancy.

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3. During construction, protect all absorptive materials stored on-site or installed from moisture damage as described in the Construction IAQ Management Plan (CIAQMP) defined above. Specifically, insulation and other absorbing materials.
4. Inspect absorptive materials stored onsite on a regular basis and record findings
5. Exercise special care at all times in the storage of materials to prevent exposure to moisture.
6. During construction and HVAC system installation, provide the Engineer with photographs of IAQ management measures (such as protection of ducts and on-site or installed absorptive materials), including photographs on different occasions depicting implemented SMACNA approaches.
7. Develop a moisture control plan as part of the CIAQMP detailing measures to prevent or remove materials with mold spores. Record observations and corrective action taken.
8. Noise & Vibration: Develop a plan based on British Standard BS5228 to reduce noise emissions & vibration during construction by specifying low emission design and Contractor to ensure construction workers wear hearing protection in areas of 85db or more. This is included as part of the CIAQMP.

3.4 IAQ ASSESSMENT

A. Flush-Out:

1. After construction ends, prior to occupancy and with all interior finishes installed, perform a building flush-out by installing new filtration media and supplying a total volume of 14,000 cu. ft. of outdoor air per sq. ft. of gross floor area while maintaining an internal temperature of at least 60°F (15° C) and no higher than 80 deg. F (27 deg. C) and a relative humidity no higher than 60 percent.

2. If occupancy is desired prior to flush-out completion, the space may be occupied following delivery of a minimum of 3500 cu. ft. of outdoor air per sq. ft. of gross floor area to the space while maintaining an internal temperature of at least 60 deg F (15 deg C) and no higher than 80 deg. F (27 deg. C) and relative humidity no higher than 60 percent. Once a space is occupied, it shall be ventilated at a minimum rate of 0.30 cfm per sq. ft. (1.52 L/s per sq. m) of outside air or the design minimum outside-air rate, whichever is greater. During each day of the flush-out period, ventilation shall begin a minimum of three hours prior to occupancy and continue during occupancy. These conditions shall be maintained until a total of 14,000 cu. ft./sq. ft. of outside air has been delivered to the space.

B. Air-Quality Testing: Engage testing agency to perform the following:
1. Conduct baseline IAQ testing, after construction ends and prior to occupancy, using testing protocols consistent with the EPA's "Compendium of Methods for the Determination of Air Pollutants in Indoor Air.
2. Demonstrate that the contaminant maximum concentrations listed below are not exceeded:
    a. Formaldehyde: 27 ppb.
    b. Particulates (PM10): 50 micrograms/cu. m.
    c. Particulates (PM2.5): 15 micrograms/cu. m.
    d. Ozone: 0.075 ppm, according to ASTM D 5149.
    e. Total Volatile Organic Compounds: 500 micrograms/cu. m.
    f. 4-Phenylcyclohexene (4-PH): 6.5 micrograms/cu. m.
    g. Carbon Monoxide: 9 ppm and no greater than 2 ppm above outdoor levels.
    h. Target Volatile Organic Compounds in California Department of Public Health "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers," Table 4-1 (except formaldehyde): Allowable concentrations in California Department of Public Health "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers," Table 4-1.
    i. The maximum allowed concentration limits for all the above mentioned target compounds shall be compared to the maximum allowable figures dictated by local codes. The more stringent requirements shall be applied.

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3. For each sampling point where the maximum concentration limits are exceeded, take corrective action until requirements have been met.
4. Air-sample testing shall be conducted as follows:
    a. All measurements shall be conducted prior to occupancy but during normal occupied hours, and with building ventilation system starting at the normal daily start time and operated at the minimum outside-air flow rate for the occupied mode throughout the duration of the air testing.
    b. Building shall have all interior finishes installed, including, but not limited to, millwork, doors, paint, carpet, and acoustic tiles. Nonfixed furnishings, such as workstations and partitions, are encouraged, but not required, to be in place for the testing.
    c. Number of sampling locations varies depending on the size of building and number of ventilation systems. For each portion of building served by a separate ventilation system, the number of sampling points shall not be less than one per 5000 sq. ft. (465 sq. m). For large open spaces, one sampling point per 50,000 sq. ft. (4654 sq. m) may be used.
    d. Air samples shall be collected between 3 and 6 feet (900 and 1800 mm) from the floor to represent the breathing zone of occupants, and over a minimum four-hour period.

3.5 CONSTRUCTION ACTIVITY POLLUTION PREVENTION PLAN

A. Before construction begins, implement the approved Construction Activity Pollution Prevention plan for all construction activities associated with the project, establish control measures before construction begins and implement additional measures as needed based on site conditions and as construction progresses. The establishment and maintenance of ESC measures are the responsibility of Contractor.

B. Monitor control measures periodically through monthly site inspections and record maintenance activities taken during construction.

C. Inspections must be recorded regularly via date-stamped photographs, inspection reports, or other recording processes.

D. Any problems identified in site inspections should be resolved in a timely manner.

E. Generate and save documentation as the plan is implemented for eventual use in the certification submission.

F. Submit drawings depicting erosion and sedimentation control measures implemented.

G. Submit a description of how the project complies with the equivalent local standards and codes.

H. Notify the Engineer in case of any damage to the ESC measures.

I. Create and submit a narrative description of ESC plan implementation that includes the following:

1. Timing of the implementation of the plan.
2. Specific control measures applied on site.
3. Maintenance protocols used to ensure the proper function of control measures.

3.6 HEAT ISLAND REDUCTION

A. Submit as built nonroof and roof area calculations.

B. Submit site plan(s) with elements and measurements, including project boundary, building footprint, roof and hardscape area, and area of each roof and nonroof measure.

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3.7 Cooling Tower Water Use

A. Conduct a one-time potable water analysis and another non-potable water (if applicable) analysis, measuring at least the five control parameters listed in the Table below.

TABLE 1. Maximum concentrations for parameters in condenser water

Parameter	Maximum level
Ca (as $CaCO_3$)	1000 ppm
Total alkalinity	1000 ppm
SiO_2	100 ppm
Cl^-	250 ppm
Conductivity	2000 μS/cm

ppm = parts per million

μS/cm = micro siemens per centimeter

B. Calculate the number of cooling tower cycles by dividing the maximum allowed concentration level of each parameter by the actual concentration level of each parameter found in the potable makeup water. Limit cooling tower cycles to avoid exceeding maximum values for any of these parameters.

C. Identify which concentration parameter has the fewest calculated cycles before it exceeds the maximum concentration. That parameter's number of cycles, the limiting factor, will determine the maximum number of cycles for the cooling tower.

3.8 COMMISSIONING REQUIREMENTS

The commissioning scope should cover all the Sustainability requirements. For more details, please refer to section 'SPC_01_SEC-019113_GENERAL COMMISSIONING REQUIREMENTS'.

A. Commissioning Team

1. Members Appointed by Contractor(s): Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action. The commissioning team shall consist of, but not be limited to, representatives of each Contractor, including Project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.

2. Members Appointed by Employer:
   - CxA: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. Employer will engage the CxA under a separate contract. The CxA must have documented commissioning process experience on at least two building projects with a similar scope of work. The experience must extend from early design phase through at least 10 months of occupancy
   - Representatives of the facility user and operation and maintenance personnel.
   - Engineer and engineering design professionals.

3. Commissioning authority should have the following qualifications:
   - The CxA must have documented commissioning process experience on at least two building projects with a similar scope of work. The experience must extend from early design phase through at least 10 months of occupancy.
   - The CxA may be a qualified employee of the owner, an independent consultant or an employee of the design or construction firm who is not part of the project's

design or construction team, or a disinterested subcontractor of the design or construction team.
- The CxA may be a qualified employee of the owner, an independent consultant or a disinterested subcontractor of the design team.
- The CxA must report their findings directly to the owner.

B. Employer's Responsibilities
1. Provide the OPR documentation to the CxA and each Contractor for information and use.
2. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities.
3. Provide the BoD documentation, prepared by Designer and approved by Employer, to the CxA and each Contractor for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.

C. Contractors' Responsibilities

Each Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:
1. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
2. Cooperate with the CxA for resolution of issues recorded in the Issues Log.
3. Attend commissioning team meetings held on a variable basis and as agreed with the Employer
4. Integrate and coordinate commissioning process activities with construction schedule.
5. Review and accept construction checklists provided by the CxA.
6. Complete paper and electronic construction checklists as Work is completed and provide to the Commissioning Authority on a weekly basis.
7. Review and accept commissioning process test procedures provided by the Commissioning Authority.
8. Complete commissioning process test procedures.

D. Commissioning Agent (CxA)'s Responsibilities
1. Organize and lead the commissioning team.
2. Review the OPR, BOD and project design.
3. Develop and implement a Commissioning plan.
4. Convene commissioning team meetings.
5. Confirm incorporation of Cx requirements into the construction documents.
6. Provide Project-specific construction checklists and commissioning process test procedures.
7. Develop a system test procedure.
8. Verify system test execution
9. Verify the execution of commissioning process activities using random sampling. The sampling rate may vary from 1 to 100 percent. Verification will include, but is not limited to, equipment submittals, construction checklists, training, operating and maintenance data, tests, and test reports to verify compliance with the OPR. When a random sample does not meet the requirement, the CxA will report the failure in the Issues Log.
10. Prepare and maintain the Issues and benefits Log throughout the Cx process.
11. Prepare a final Cx process report.
12. Document all findings and recommendations and report directly to the owner throughout the process.
13. Review the exterior enclosure design.
14. Prepare and maintain a current facilities requirements and operation and maintenance plan that contains the information necessary to operate the building efficiently. The plan must include the following:
    - A sequence of operations for the building.
    - The building occupancy schedule.
    - Equipment run-time schedule.
    - Setpoints for all HVAC equipment

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- Set lighting levels throughout the building
- Minimum outside air requirements
- Any changes in schedule or setpoints for different seasons, days of the week and times of day
- A systems narrative describing the mechanical and electrical systems and equipment
- A preventive maintenance plan for building equipment described in the systems narrative

15. A commissioning program that includes periodic commissioning requirements, ongoing commissioning tasks, and continuous tasks for critical facilities. Prepare and maintain completed construction checklist log.
16. Witness systems, assemblies, equipment, and component startup.
17. Compile test data, inspection reports, and certificates; include them in the systems manual and commissioning process report.
18. Review Contractor submittals.
19. Verify inclusion of system manual requirements in construction documents.
20. Verify inclusion of operator and occupant training requirements in construction documents.
21. Verify systems manual updates and delivery.
22. Verify operator and occupant training delivery and effectiveness.
23. Verify seasonal testing.
24. Review building operations 10 months after substantial completion.
25. Develop an on-going commissioning plan.
26. Include all enhanced commissioning tasks in the OPR and BOD.
27. Develop monitoring-based procedures and identify points to be measured and evaluated to assess performance of energy and water consuming systems.
28. Include the procedures and measurement points in the commissioning plan. Address the following:
    a. Roles and responsibilities;
    b. Measurement requirements (meters, points, metering systems, data access);
    c. The points to be tracked, with frequency and duration for trend monitoring;
    d. The limits of acceptable values for tracked points and metered values (where appropriate, predictive algorithms may be used to compare ideal values with actual values);
    e. The elements used to evaluate performance, including conflict between systems, out of sequence operation of systems components, and energy and water usage profiles;
    f. An action plan for identifying and correcting operational errors and deficiencies;
    g. Training to prevent errors;
    h. Planning for repairs needed to maintain performance; and
    i. The frequency of analyses in the first year of occupancy (at least quarterly).
29. Update the systems manual with any modifications or new settings, and give the reason for any modifications from the original design.
30. Fulfill the Sustainability requirements of fundamental commissioning and verification as they apply to the building's thermal envelope in addition to mechanical and electrical systems and assemblies.
31. Complete the following commissioning process activities for the building's thermal envelope in accordance with ASHRAE guideline 0-2005 and the national institute of building science (NIBS) guideline 3-2012, exterior enclosure technical requirements for the commissioning process as they relate to energy, water, indoor environmental quality and durability, commissioning authority must complete the following:

    a. Review contractor submittals
    b. Verify inclusion of systems manual requirements in construction documents
    c. Verify inclusion of operator and occupant training requirements in construction documents
    d. Verify system manual updates and delivery
    e. Verify operator and occupant training delivery and effectiveness
    f. Verify seasonal testing
    g. Review building operations 10 months after substantial completion

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32. Develop an ongoing commissioning plan.

END OF SECTION 018113.14

SECTION 019112 - SYSTEM STARTUP AND TESTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions and other Division 01 Specifications sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the startup and testing requirements for the equipment / systems supplied and / or installed. The Contractor shall be responsible for providing complete startup, testing, and operator training services to demonstrate operability of all electrical and mechanical equipment / systems supplied and any Employer-furnished components and materials provided.

B. In the absence of main permanent power availability from the Utility Provider or any other permanent source, the Contractor shall be responsible for providing the full power required, on temporary basis, using Contractor's supplied and operated back-up generators, for all systems startup, testing and commissioning activities. Such temporary power from back-up generators shall remain in operation until permanent power becomes available.

C. Related Requirements:
   1. Specification sections related to the functionality and efficiency of the executed systems.

1.3 DEFINITIONS

A. Wherever the Specifications of this Contract refer to 'copy or copies' in whatsoever form it means the 'copy or copies' read, reproduced, communicated and stored through the Project Website as defined in clause 1.9 of Section 013100.

PART 2 - PRODUCTS: (NOT USED)

PART 3 - EXECUTION

3.1 FIELD TESTS AND ADJUSTMENTS

A. Pre-Commissioning:

   1. All mechanical and electrical equipment including the interfaces with the building management system, control systems, communication systems, software and all alarm circuits and operating modes for each piece of equipment shall be tested by the Contractor and approved by the Engineer before any facility is put into operation. Tests shall be as specified herein and in the Specification Section applicable to and as specified for the various pieces of equipment. The testing and commissioning are to be done in the presence of the equipment manufacturer / supplier authorized representative. As a minimum, the startup tests shall be sufficiently detailed and comprehensive to demonstrate and verify that the equipment has been properly assembled, aligned, and connected and that the control and information circuitry and any associated controllers, panels, and software systems are fully operational

and functioning as designed. Any changes, adjustments, or replacements required to make the equipment operate as specified shall be performed as part of the Works.

2. At least sixty (60) days before the time allowed in the construction schedule for commencing testing and startup activities, submit to the Engineer electronic copy of the detailed procedures proposed, based on the manufacturer's recommendations and relevant Divisions Specifications, for testing and startup of all mechanical (including instrumentation and controls) and electrical equipment. Procedures shall be required for each major piece of equipment, each subsystem which can logically be treated as an integral group and division for purposes of testing and demonstrating system operability.
3. Testing and startup procedures shall include detailed descriptions of all pre-operational electrical, mechanical, communication and software and instrumentation testing work. Each control device, item of mechanical, electrical, and instrumentation equipment, software and all control circuits shall be considered in the testing procedures. The testing procedures shall be established / prepared in a stepwise, logical sequence to verify that all equipment has been properly serviced, aligned, connected, wired, calibrated, and adjusted prior to operation. Motors shall be tested in accordance with ANSI / IEEE Publication 112. Testing procedures shall be designed to duplicate as nearly as possible all conditions of operations and shall be carefully selected to ensure that the equipment is not damaged as a result of the testing program. All filters and filter elements shall be installed prior to beginning the tests. Construction or temporary filters shall be used during startup activities and shall be replaced with new unused ones before system handing over.
4. Once the testing procedures have been approved by the Engineer, provide checkout, alignment, adjustment, and calibration signoff forms for each item of equipment and system that will be used. The signoff forms shall be used at the Site jointly with Engineer, to demonstrate that each item of electrical, mechanical, and instrumentation equipment and system has been properly installed and tested. Cooperate with the contractors of other systems / facilities where startup and testing are to be conducted concurrently. Performance of any system shall be based on suitable ambient conditions with consideration to all diversity factors.
5. Any special testing equipment, loads or instrumentation required shall be provided to the Employer at the Contractor's cost during startup and pre-operational testing of systems and equipment.

B. Post Commissioning:

1. Before starting a system, perform all service on all equipment, which comprises the system and associated equipment that supports the system, which normally requires service in accordance with the Operation & Maintenance Manual instructions. Submit a detailed maintenance schedule and be responsible for lubrication and maintenance of equipment and filters throughout the entire equipment break-in period indicated by the manufacturer. Note that, when the manufacturer does not specify a break-in period, construction or temporary filters shall be installed and the new and clean filters shall be installed only after the system and equipment are thoroughly cleaned to the satisfaction of the Engineer.
2. Be responsible for the startup, adjustment, preliminary maintenance, and checkout of all equipment and instrumentation. All systems shall be carefully checked for conformance with the Contract Documents including Design Drawings, Specifications, and other Contract documents, which provide performance requirements (e.g., Design Criteria document(s) when provided by the Employer as part of the Contract Package).
3. If any equipment or system does not operate as specified in the Contract Documents, replace or repair components until they operate properly and meet the specified performance requirements.
4. When system startup and testing is complete, submit ("draft") test reports to the Engineer for review and acceptance within two (2) weeks of the completion of the tests and before the final test reports are issued (no later than one month from the final date of completion of the tests).

3.2 FINAL INSTRUCTIONS AND OPERATION TRAINING

A. After all testing is completed, demonstrate to the Employer the proper manner of operating the equipment, adjusting, responding to alarms and emergency signals, and maintaining the systems. Each system shall include a minimum of 8 hours of operator training. Note that major systems like HVAC System and other important systems shall be tested and a minimum of eight (8) hours of operator training provided for each major sub-system as defined in the other Divisions Specifications, or as agreed with the Engineer. Operator schools shall be conducted as applicable with duly qualified instructors. Work performed by the manufacturer's representative required for testing shall not be considered as operator training even if the operators are present and witnessing the adjustments. Equipment testing shall be completed and Operations and Maintenance Manuals submitted and approved before the required on-the-job operator training begins.

B. Prepare and furnish training materials for use in training Employer’s personnel. The training materials shall be submitted for the Engineer's review 3 weeks in advance of training and shall include detailed comprehensive written documents / procedures which clearly describe all startup, maintenance, troubleshooting, and service procedures for all equipment and systems, video clips, professionally produced and edited may be utilized as suitable media for at least a portion of the training program.

C. The Contractor shall carry out, to the satisfaction of the above Clauses to the Employer requirements, preventive and breakdown maintenance for the equipment and systems as per manufacturer’s recommendations.

3.3 SYSTEMS STARTUP (PERFORMANCE WARRANTY RUN)

A. Be responsible for a thirty (30) days period of completed systems operation, during which electrical and mechanical equipment, fixtures, and associated devices shall be energized and operated under local and automatic (remote) controls, in all intended design operating modes. Be present with system manufacturer’s / supplier’s representative(s) during the startup period with adequate labor and support personnel to perform needed adjustments and troubleshoot system failures and / or any performance deficiencies that might arise and to perform necessary corrective actions.

B. When mechanical, electronic / hardware / software or electrical equipment is found to be deficient compared with the specified performance criteria/requirements, adjustments shall be made by a qualified representative of the manufacturer.

C. If adjustments fail to correct the operation and performance of equipment, remove the equipment from the Site and replace it with new equipment that meets the specified requirements.

3.4 INTEGRATED STARTUP AND TESTING

A. The thirty (30) days startup (system warranty run) period shall commence at the time of completion. If during this period, the system fails to operate and perform in accordance with Contract Document requirements, the failure shall be corrected and the 30-day performance warranty run period shall begin again.

END OF SECTION 019112

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SECTION 019113 - GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions and other Specification Sections, apply to this Section.

B. Owner's (Employer's) Project Requirements and Basis-of-Design Document are included by reference for information only.

1.2 SUMMARY

A. This Section specifies the requirements and procedures for project systems commissioning activities. This work is to be done in conjunction with the commissioning and associated activities (i.e. testing, start up, training and other activities) specified in the various trade specifications and provides an organized format for the commissioning process.

B. Section includes:
1. General requirements that apply to implementation of commissioning without regard to specific systems, assemblies, or components.
2. General requirements for coordinating and scheduling commissioning activities.
3. Commissioning meetings.
4. Commissioning reports.
5. Use of commissioning process test equipment, instrumentation, and tools.
6. Construction checklists, including, but not limited to, installation checks, startup, performance tests, and performance test demonstration.
7. Commissioning tests and commissioning test demonstration.
8. Adjusting, verifying, and documenting identified systems and assemblies.

C. Related Requirements:
1. Section 013300 "Submittal Procedures" for submittal procedure requirements for commissioning process.
2. Section 017700 "Closeout Procedures" for Certificate of Construction-Phase Commissioning Process Completion submittal requirements.
3. Section 017823 "Operation and Maintenance Data" for preliminary operation and maintenance data submittal requirements.
4. Division 01 Section 019119.43 "Exterior Enclosure Commissioning" for technical commissioning requirements for exterior closure.
5. Section 018113.14 "Sustainable Design Requirements" for Sustainability requirements.
6. ASHRAE Guideline 0-2005 and ASHRAE Guideline 1.1-2007 for HVAC&R systems as they relate to energy, water, indoor environmental quality and durability.
7. NIBS Guideline 3-2012.
8. Division 14 for technical commissioning requirements for conveying systems.
9. Section 210800 "Commissioning of Fire Suppression" for technical commissioning requirements for fire suppression.
10. Section 220800 "Commissioning of Plumbing" for technical commissioning requirements for plumbing.
11. Section 230800 "Commissioning of HVAC" for technical commissioning requirements for HVAC.
12. Division 26 for technical commissioning requirements for electrical systems.
13. Division 27, for technical commissioning requirements for communications systems

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14. Division 28, for technical commissioning requirements for electronic safety and security systems.
15. Specification sections related to the functionality and efficiency of the executed systems

1.3 DEFINITIONS

A. Acceptance Criteria: Threshold of acceptable work quality or performance specified for a commissioning activity, including, but not limited to, construction checklists, performance tests, performance test demonstrations, commissioning tests, and commissioning test demonstrations.

B. Basis-of-Design Document: A document prepared by Engineer that records concepts, calculations, decisions, and product selections used to comply with Employer's Project Requirements and to suit applicable regulatory requirements, standards, and guidelines.

C. Commissioning Authority: An entity to evaluate Commissioning-Process Work.

D. Commissioning Plan: A document, prepared by Commissioning Authority, that outlines the organization, schedule, allocation of resources, and documentation of commissioning requirements.

E. Commissioning: A quality-focused process for verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, and tested to comply with Employer's Project Requirements. The requirements specified here are limited to the construction phase commissioning activities.

F. Construction-Phase Commissioning-Process Completion: The stage of completion and acceptance of commissioning process when resolution of deficient conditions and issues discovered during commissioning process and retesting until acceptable results are obtained has been accomplished.

1. Commissioning process is complete when the Work specified of this Section and related Sections has been completed and accepted, including, but not limited to, the following:

a. Completion of tests and acceptance of test results.
b. Resolution of issues, as verified by retests performed and documented with acceptance of retest results.
c. Comply with requirements in Section 017900 "Demonstration and Training."
d. Completion and acceptance of submittals and reports.

G. Owner's (Employer’s) Project Requirements: A document that details the functional requirements of a project and the expectations of how it will be used and operated, including Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information. This document is prepared either by the Employer or for the Employer by the Engineer or Commissioning Authority.

H. Employer's Witness: Commissioning Authority, Employer's Project Manager, or Engineer-designated witness authorized to authenticate test demonstration data and to sign completed test data forms.

I. "Systems," "Assemblies," "Subsystems," "Equipment," and "Components": Where these terms are used together or separately, they shall mean "as-built" systems, assemblies, subsystems, equipment, and components.

J. Test: Performance tests, performance test demonstrations, commissioning tests, and commissioning test demonstrations.

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1.4 DESCRIPTION

A. The purpose of the Commissioning process is to provide the Employer/Operator of the facilities with a higher level of assurance that the systems are carefully planned and coordinated and have been installed in the prescribed manner, and that will operate within the performance guidelines, and to ensure the proper integrated commissioning of its various systems.

B. To meet the above-mentioned task, the Contractor shall provide within his site organization the services of a qualified Commissioning Committee headed by a qualified Commissioning Manager from the outset of the Contract. The Commissioning Committee shall be a separate and dedicated team within the Contractor's site organization.

C. Throughout the course of the Contract, the Contractor shall supplement the services of the Commissioning Committee by the appointment of further qualified staff in order to create commissioning activities of the Contractor and his sub-contractors in such a way as to ensure the successful integrated commissioning of the installed systems within the timeframe of the Contract.

D. The Commissioning Committee shall be a separate and dedicated team within the Contractor's to Sub-contractors site organization, solely for the planning, organization, coordination, preparation, implementation and documentation of the Contractor and Sub-contractors commissioning obligations.

E. The Contractor shall indicate his intentions in relation to the staffing of the Commissioning Committee in an organization chart but shall undertake to ensure that all times adequate numbers of personnel, of adequate experience and training are available to fulfill the specified objectives.

F. Prior to making any appointment to meet the above obligations, the Contractor shall submit, for the Engineer's approval full resumes of the staff concerned. It will be an obligation upon the Contractor to ensure, before submittal, that the staff proposed has adequate experience to undertake the duties that they are being proposed for.

G. The Commissioning Committee shall be responsible for the planning, coordination, safety and execution of the Contractor's integrated commissioning of the installed systems of the works. It is, however, implicitly to be understood that actions of the Contractor and his Commissioning Committee shall not relieve the Contractor of his obligations to ensure that the Engineer is kept fully informed of all activities of the Commissioning Committee and is informed of all planning decisions, provided with all schedules, test schedules and test procedures, details of tests and of testing times and dates in adequate time and in adequate detail in order to ensure that the Engineer is able to approve where necessary, monitor, witness, and the like, the activities of the Commissioning Committee and the commissioning process.

H. No approval other than that of the Engineer shall be considered with respect to the commissioning process and the acceptance of equipment, systems and integrated systems.

I. The Contractor's attention is drawn to the obligations that he undertakes, under the provisions of this contract, in respect to training. Although not specifically mentioned herein, it is to be understood that as part of such training requirements, the Employer/Operator and/or their representatives or direct contractors nominated by the Employer to partake in such training upon his behalf, may at any time attend tests or commissioning activities as witnesses and/or as part of such training activities.

1.5 COMMISSIONING TEAM

A. Members appointed by Contractor: Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action. The commissioning team shall consist of, but not be limited to, representatives of Contractor, subcontractors, installers, suppliers, and specialists deemed appropriate.

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1. Commissioning Coordinator: A person or entity employed by Contractor to manage, schedule, and coordinate commissioning process.
2. Project superintendent and other employees that Contractor may deem appropriate for a particular portion of the commissioning process.
3. Subcontractors, installers, suppliers, and specialists that Contractor may deem appropriate for a particular portion of the commissioning process.
4. Appointed team members shall have the authority to act on behalf of the entity they represent.

B. Members Appointed by Employer:
1. Facility operations and maintenance personnel, plus other employees, and separate contractors, that Employer may deem appropriate for a particular portion of the commissioning process.

C. Commissioning Authority should have the following qualifications:
1. The Commissioning Authority must have documented commissioning process experience on at least two building projects with a similar scope of work. The experience must extend from early design phase through at least 10 months of occupancy.
2. Commissioning Authority must report their findings directly to the Employer.

1.6 SCOPE OF WORK AND RESPONSIBILITY OF COMMISSIONING COMMITTEE (TEAM)

A. As part of its responsibilities, the Commissioning Committee shall:

1. Inform the Engineer on the integration and performance of systems within the facility.
2. Disseminate information and assist the design and construction teams of the Contractor to complete the certification process. This will include system completeness, performance and adequacy to meet the intended performance standards of each system.
3. Create a commissioning plan, which will describe in detail all commissioning functions, actions, tests, documentation and schedule.
4. Verify and document the following field tests and observations:

a. Field Installation Verification (FIV). Verification of all installed systems for compliance to plans and specification.
b. Operation Performance Tests (OPT). Operational tests which verify proper start-up of all equipment and systems. These tests are to be described in detail in the commissioning plan.
c. Functional Performance Tests (FPT). Functional system tests that verify all systems are functioning and interacting with other systems correctly. These tests are to be described in detail in the commissioning plan.

B. The primary role of the Contractor's Commissioning Committee (team) is to identify the commissioning scope, and plan, develop, prepare for and co-ordinate the execution of an integrated overall start-up commissioning plan, for the Contractor and his Sub-contractors, for the Contract.

C. The Contractor and his Commissioning Committee shall perform the coordination with other contractors responsible for executing works for the Employer under other contracts referred to in the specification and make sure that all the interfaces between the different contracts are taken into consideration and are implemented and detailed in the integrated overall start-up commissioning plan.

D. An integral part of such duties will be to observe and document the performance of systems and the inter-relationships of the systems to ensure that they are functioning in accordance with the documented project intent and in accordance with the Contract Documents.

E. An essential element of the fulfillment of such aims and obligations will be the Commissioning Committee's involvement in the contract submittal process and the identification, at the submittal/approval stage, of the related commissioning requirements and the commencement of the commissioning process.

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F. The Contractor will provide all tools, or the use of tools; to start, checkout and functionally test equipment and systems, including the specified testing with portable data loggers.

G. All equipment and systems that are installed shall be individually and integrally commissioned as an obligation by the Contractor and his Commissioning Committee (team).

H. The following provides a non-limitative list as applicable:

1. Fuel Hydrants system.
2. Aircraft Stand Equipment "ASE" (Visual Docking Guidance System "VDGS", Pre-conditioned Air System "PCA", Aircraft Passenger Loading Bridges "PLBs", & 400 Hz Ground Power System).
3. Conveying systems (Elevators, escalators, and moving walks).
4. Baggage handling systems and subsystems, including all control systems.
5. Fire Protection System.
6. Plumbing Work.
7. HVAC System and subsystems, including all control systems and software.
8. Airfield Lighting/equipment System.
9. Lighting System.
10. UPS System.
11. MV & LV Power Supply System.
12. Lightning Protection System.
13. ATCT Equipment/systems.
14. Information Communication Technologies "ICT" systems.
15. All any other equipment and system and subsystems forming part of the contract and is not addressed above.

I. During construction, the following activities shall represent, without limitation as to overall scope, the typical scope of work for the Contractor's Commissioning Committee (team).

1. Coordinate and direct the commissioning activities with the Contractor organization in a logical, sequential and efficient manner using consistent protocols and forms, centralized documentation, clear and regular communications and consultations with all necessary parties, frequently updated timelines and schedules and all necessary technical expertise.
2. Coordinate the commissioning work and ensure that commissioning activities are scheduled in the construction programme and the commissioning plan to be submitted for the approval of the Engineer.
3. Plan and call for a commissioning scoping meeting and other commissioning meetings.
4. Plan and implement all safety requirements and precautions.
5. Request and review additional information required to perform commissioning tasks, including O&M materials, start-up and checkout procedures.
6. Before start-up, gather and review the current control sequences and interlocks and work with Contractor and Contractor's design engineers and with other contracts under execution by others, until sufficient clarity has been obtained, in writing, to be able to write detailed testing procedures which shall be subject to the Engineer's approval.
7. Review all normal submittals, applicable to equipment and systems requiring commissioning, for compliance with commissioning needs.
8. Prepare and distribute pre-functional tests and checklists.
9. Develop an enhance start-up and initial system checkout plan with all Contractor's Sub-contractors/suppliers /vendors.
10. Observe component and system installations. Attend selected planning and job-site meetings to obtain information on construction progress. Review construction meeting minutes for revisions/substitutions relating to the commissioning process. Assist in resolving any discrepancies.
11. With the assistance and review from installing sub-contractors, Commissioning Committee shall prepare, for approval by the Engineer, the functional performance test procedure for equipments and systems.

12. Submit for the Engineer's approval pre-functional tests and checklist completion after reviewing and checking pre-functional checklist reports submitted by Sub-contractors and by site observation and spot checking.
13. Submit for the Engineer's approval systems startup after reviewing and checking start-up reports and by site observation.
14. Analyze and functional performance trend logs and monitoring date to verify performance.
15. Coordinate and witness with the Engineer manual functional performance tests performed by the Contractor or his installing Sub-contractors. Submit the results from the said tests for approval. Coordinate and retesting that proves necessary until satisfactory performance is achieved.
16. Maintain in the Engineer's offices, or at a place otherwise agreed, a master deficiency and resolution log and a separate testing record. Submit to the Engineer written progress reports and all original test results records along with recommended actions necessary.
17. Prior to submittal review equipment warranties to ensure that the Employer's rights are clearly define. Submit all such warranties to the Engineer for approval.
18. Plan, programme, compile and maintain in the Engineer's offices or in another place to be agreed, a commissioning record and systems book (s).
19. Prior to submittal for approval review and amend as necessary the preparation of the O&M manuals.
20. Prepare and provide the Contractor final commissioning report.

1.7 COORDINATION

A. The Commissioning Committee (team) will report on a regular basis to the Engineer and will comply with any instructions issued by the Engineer in respect to any commissioning activity or actions of the committee.

Likewise, the commissioning team will work closely with the design teams assigned by the Contractor to perform design.

It is an obligation upon the Contractor to ensure that all his installing sub-contractors or supplier of equipment are aware from the outset that they will be required to report to and cooperate fully with Contractor's Commissioning Committee in order to ensure the successful completion of the integrated commissioning.

1.8 INFORMATIONAL SUBMITTALS

A. Comply with requirements in Section 013300 "Submittal Procedures" for submittal procedure general requirements for commissioning process.

B. Commissioning Plan Information:

1. List of Contractor-appointed commissioning team members to include specific personnel and subcontractors performing the various commissioning requirements.
2. Schedule of commissioning activities, integrated with the Construction Schedule. Comply with requirements in Section 013200 "Construction Progress Documentation" for the Construction Schedule general requirements for commissioning process.
3. Contractor personnel and subcontractors participating in each test.
4. List of instrumentation required for each test to include identification of parties that will provide instrumentation for each test.

C. Commissioning schedule.

D. Two-week look-ahead schedules.

E. Commissioning Coordinator Letter of Authority:

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1. Within 10 days after approval of Commissioning Coordinator qualifications, submit a letter of authority for Commissioning Coordinator, signed by a principal of Contractor's firm. Letter shall authorize Commissioning Coordinator to do the following:

    a. Make inspections required for commissioning process.
    b. Coordinate, schedule, and manage commissioning process of Contractor, subcontractors, and suppliers.
    c. Obtain documentation required for commissioning process from Contractor, subcontractors, and suppliers.
    d. Report issues, delayed resolution of issues, schedule conflicts, and lack of cooperation or expertise on the part of members of the commissioning team.

F. Commissioning Coordinator Qualification Data: For entity coordinating Contractor's commissioning activities to demonstrate their capabilities and experience.

1. Experienced: When used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

G. List test instrumentation, equipment, and monitoring devices. Include the following information:

1. Make, model, serial number, and application for each instrument, equipment, and monitoring device.
2. Brief description of intended use.
3. Calibration record showing the following:

    a. Calibration agency, including name and contact information.
    b. Last date of calibration.
    c. Range of values for which calibration is valid.
    d. Certification of accuracy.
    e. Certification for calibration equipment traceable to NIST.
    f. Due date of the next calibration.

H. Test Reports:

1. Pre-Startup Report: Prior to startup of equipment or a system, submit signed, completed construction checklists.
2. Test Data Reports: At the end of each day in which tests are conducted, submit test data for tests performed.
3. Commissioning Issue Reports: Daily, at the end of each day in which tests are conducted, submit commissioning issue reports for tests for which acceptable results were not achieved.
4. Weekly Progress Report: Weekly, at the end of each week in which tests are conducted, submit a progress report.
5. Data Trend Logs: Submit data trend logs at the end of the trend log period.
6. System Alarm Logs: Daily, at the start of days following a day in which tests were performed, submit printout of log of alarms that occurred since the last log was printed.

I. Construction Checklists:

1. Material checks.
2. Installation checks.
3. Startup procedures, where required.

1.9 ACTION SUBMITTALS

A. The Contractor’s Commissioning Manager will provide appropriate Sub-contractors, Suppliers, Vendors, Installers with a specific request for the type of submittal documentation the Contractor’s

Commissioning Manager requires to facilitate the commissioning work; forms related to (Commissioning Request for Information) will be prepared by the Commissioning Committee and agreed upon with the Engineer. These requests will be integrated into the normal submittal process and protocol of the Contractor's construction team. At minimum, the request will include the manufacturer and model number, the manufacturer's printed installation and detailed start-up procedures, full sequences of operation, O&M data, performance data, any performance test procedures, control drawings and details of Employer contracted tests. All documentation requested by the Commissioning Committee will be included by the Contractor and his Sub-contractors in their O&M manual contributions.

B. The Commissioning Committee and involved parties will review submittals related to the commissioned equipment for conformance to the Contract Documents as it relates to the commissioning process, to the functional performance of the equipments and adequacy for developing test procedures. This review is intended primarily to aid in the development of functional testing procedures and only secondarily to verify compliance with equipment specification. The Engineer shall be notified by the Commissioning Committee, of items missing or areas that are not in conformance with Contract Documents and which require resubmission.

C. The O&M manuals submittals and compliance with the requirements remain the responsibility of the Contractor.

D. No approval other than that of the Engineer shall be considered with request to the commissioning process submittals related acceptance of equipment, systems and integrated systems and reports tests and manuals submittals.

1.10 CLOSEOUT SUBMITTALS

A. Commissioning Report:

1. At Construction-Phase Commissioning Completion, include the following:

   a. Pre-startup reports.
   b. Approved test procedures.
   c. Test data forms, completed and signed.
   d. Progress reports.
   e. Commissioning issue report log.
   f. Commissioning issue reports showing resolution of issues.
   g. Correspondence or other documents related to resolution of issues.
   h. Other reports required by commissioning process.
   i. List unresolved issues and reasons they remain unresolved and should be exempted from the requirements for Construction-Phase Commissioning Completion.
   j. Report shall include commissioning work of Contractor.

B. Request for Certificate of Construction-Phase Commissioning Process Completion.

C. Operation and Maintenance Data: For proprietary test equipment, instrumentation, and tools to include in operation and maintenance manuals.

1.11 QUALITY ASSURANCE

A. Commissioning Coordinator Qualifications:

1. Documented experience commissioning systems of similar complexity to those contained in these documents on at least three projects of similar scope and complexity.
2. Certification of commissioning-process expertise. The following certifications are acceptable. The Employer reserves the right to accept or reject certifications as evidence of qualification.

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a. Certified Commissioning Authority, by AABC Commissioning Group (ACG).
b. Commissioning-Process Management Professional, by American Society of Heating, Refrigerating and Air-Conditioning Engineers.
c. Certified Commissioning Professional, by Building Commissioning Association.
d. Accredited Commissioning-Process Authority Professional, by University of Wisconsin.
e. Accredited Commissioning-Process Manager, by University of Wisconsin.
f. Accredited Green Commissioning-Process Provider, by University of Wisconsin.

B. Calibration Agency Qualifications:

1. Documented experience commissioning systems of similar complexity to those contained in these documents on at least three projects of similar scope and complexity.
2. Certification that the calibration agency complies with the minimum requirements of ISO/IEC 17025.

C. Commissioning results must be recorded and available for inspection.

1. A systems manual, documenting the information required to allow future operations staff to understand and optimally operate the commissioned services, must be developed and provided to the building operator, upon completion of commissioning works.

1.12 EMPLOYER'S RESPONSIBILITIES

A. Provide the OPR documentation to Commissioning Authority and Contractor for information and use.

B. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities.

C. Provide the BoD documentation, prepared by Designer and approved by Employer, to Commissioning Authority and Contractor for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.

1.13 CONTRACTOR'S RESPONSIBILITIES

A. Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:

1. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
2. Cooperate with the Commissioning Authority for resolution of issues recorded in the Issues Log.
3. Attend commissioning team meetings held on a variable basis and as agreed with the Employer
4. Integrate and coordinate commissioning process activities with construction schedule.
5. Review and accept construction checklists provided by the Commissioning Authority.
6. Complete electronic construction checklists as Work is completed and provide to the Commissioning Authority on a weekly basis.
7. Review and accept commissioning process test procedures provided by the Commissioning Authority.
8. Complete commissioning process test procedures.

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1.14 COMMISSIONING AUTHORITY'S RESPONSIBILITIES

A. Organize and lead the commissioning team.

B. Review the OPR, BOD and project design.

C. Develop and implement a Commissioning plan.

D. Convene commissioning team meetings.

E. Confirm incorporation of Commissioning requirements into the construction documents.

F. Provide Project-specific construction checklists and commissioning process test procedures.

G. Develop a system test procedure.

H. Verify system test execution.

I. Verify the execution of commissioning process activities using random sampling. The sampling rate may vary from 1 to 100 percent. Verification will include, but is not limited to, equipment submittals, construction checklists, training, operating and maintenance data, tests, and test reports to verify compliance with the OPR. When a random sample does not meet the requirement, the Commissioning Authority will report the failure in the Issues Log.

J. Prepare and maintain the Issues and benefits Log throughout the Cx process.

K. Prepare a final Cx process report.

L. Document all findings and recommendations and report directly to the Employer throughout the process.

M. Review the exterior enclosure design.

N. Prepare and maintain completed construction checklist log.

O. Witness systems, assemblies, equipment, and component startup.

P. Compile test data, inspection reports, and certificates; include them in the systems manual and commissioning process report.

Q. Prepare and maintain a current facilities requirements and operation and maintenance plan that contains the information necessary to operate the building efficiently. The plan must include the following:
   - A sequence of operations for the building.
   - The building occupancy schedule.
   - Equipment run-time schedule.
   - Setpoints for all HVAC equipment
   - Set lighting levels throughout the building
   - Minimum outside air requirements
   - Any changes in schedule or setpoints for different seasons, days of the week and times of day
   - A systems narrative describing the mechanical and electrical systems and equipment
   - A preventive maintenance plan for building equipment described in the systems narrative
   - A commissioning program that includes periodic commissioning requirements, ongoing commissioning tasks, and continuous tasks for critical facilities.

Enhanced Commissioning requirements:

- Path 1 : Enhanced Commissioning

Complete the following commissioning process (CxP) activities for mechanical, electrical, plumbing, and renewable energy systems and assemblies in accordance with ASHRAE Guideline 0–2005 and ASHRAE Guideline 1.1–2007 for HVAC&R systems, as they relate to energy, water, indoor environmental quality, and durability.
The Commissioning Authority must do the following:

A. Review Contractor submittals.

B. Verify inclusion of system manual requirements in construction documents.

C. Verify inclusion of operator and occupant training requirements in construction documents.

D. Verify systems manual updates and delivery.

E. Verify operator and occupant training delivery and effectiveness.

F. Verify seasonal testing.

G. Review building operations 10 months after Taking Over.

H. Develop an on-going commissioning plan.

I. Include all enhanced commissioning tasks in the OPR and BOD.

J. Option 1 Path 2: Enhanced and Monitoring-Based Commissioning: Develop monitoring-based procedures and identify points to be measured and evaluated to assess performance of energy and water consuming systems.

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Develop monitoring-based procedures and identify points to be measured and evaluated to assess performance of energy- and water-consuming systems.

Include the procedures and measurement points in the commissioning plan. Address the following:

1. roles and responsibilities;
2. measurement requirements (meters, points, metering systems, data access);
3. the points to be tracked, with frequency and duration for trend monitoring;
4. the limits of acceptable values for tracked points and metered values (where appropriate, predictive algorithms may be used to compare ideal values with actual values);
5. the elements used to evaluate performance, including conflict between systems, out of sequence operation of systems components, and energy and water usage profiles;
6. an action plan for identifying and correcting operational errors and deficiencies;
7. training to prevent errors;
8. planning for repairs needed to maintain performance; and
9. the frequency of analyses in the first year of occupancy(at least quarterly).

K. Update the systems manual with any modifications or new settings, and give the reason for any modifications from the original design.

L. And Option 2. Envelope Commissioning

1. Fulfill the requirements of fundamental commissioning and verification as they apply to the building’s thermal envelope in addition to mechanical and electrical systems and assemblies.

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2. Complete the following commissioning process activities for the building's thermal envelope in accordance with ASHRAE guideline 0-2005 and the national institute of building science (NIBS) guideline 3-2012, exterior enclosure technical requirements for the commissioning process as they relate to energy, water, indoor environmental quality and durability, Commissioning Authority must complete the following:
   a. Review Contractor submittals.
   b. Verify inclusion of systems manual requirements in construction documents.
   c. Verify inclusion of operator and occupant training requirements in construction documents.
   d. Verify system manual updates and delivery.
   e. Verify operator and occupant training delivery and effectiveness.
   f. Verify seasonal testing.
   g. Review building operations 10 months after Taking Over.
   h. Develop an ongoing commissioning plan.

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PART 2 - PRODUCTS

2.1 GENERAL

A. Commissioning of air distribution systems, water distribution systems, lighting, central control and building management systems, refrigeration systems and boilers must be carried out.

1. Commissioning must be carried out in accordance with the CIBSE Codes listed below or other commissioning standard or code.

1.1. 'The Chartered Institution of Building Services Engineers (CIBSE) Commissioning Code, Air Distribution Systems, Code A-2006'

1.2. 'CIBSE Commissioning Code, Water Distribution Systems, Code W-2010'

1.3. 'CIBSE Commissioning Code, Lighting, Code L-2018'

1.4. 'CIBSE Commissioning Code, Automatic Controls, Code C-2001' for central control and Building Management System (BMS);

1.5. 'CIBSE Commissioning Code R: 2002 Refrigeration Systems; and

1.6. 'CIBSE Commissioning Code B: 2002 Boilers'.

2. Commissioning results must be recorded.

3. A systems manual, documenting the information required to allow future operations staff to understand and optimally operate the commissioned services, must be developed and provided to the building operator, upon completion of commissioning works.

2.2 TEST EQUIPMENT, INSTRUMENTATION, AND TOOLS

A. All industry standard test equipment required for performing the tests specified herein shall be provided by the Contractor. If any special data logging equipment is required, for any FPT, the equipment shall be provided by the Contractor, the Contractor may arrange with his sub-contractors/suppliers/vendors for the provision of any special data logging equipment required.

B. All instrumentation shall meet the following standards:

1. Be of sufficient quality and accuracy to test and/or measure system performance within the tolerances required to determine adequate performance.
2. Be calibrated on the manufacturer's recommended intervals with calibration tags permanently affixed to the instrument being used.
3. Be maintained in good repair and operating condition throughout the duration of use on this project.
4. Be recalibrated/repaired if dropped and/or damaged in any way during use on this project.

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C. Test equipment and instrumentation required to perform the commissioning process shall remain the property of Contractor unless otherwise indicated.

D. Test equipment and instrumentation required to perform commissioning process shall comply with the following criteria:

1. Be manufactured for the purpose of testing and measuring tests for which they are being used and have an accuracy to test and measure system performance within the tolerances required to determine acceptable performance.
2. Calibrated and certified.

    a. Calibration performed and documented by a qualified calibration agency according to national standards applicable to the tools and instrumentation being calibrated. Calibration shall be current according to national standards or within test equipment and instrumentation manufacturer's recommended intervals, whichever is more frequent, but not less than within six months of initial use on Project. Calibration tags shall be permanently affixed.
    b. Repair and recalibrate test equipment and instrumentation if dismantled, dropped, or damaged since last calibrated.

3. Maintain test equipment and instrumentation.
4. Use test equipment and instrumentation only for testing or monitoring Work for which they are designed.

2.3 PROPRIETARY TEST EQUIPMENT, INSTRUMENTATION, AND TOOLS

A. Proprietary test equipment, instrumentation, and tools are those manufactured or prescribed by tested equipment manufacturer and required for work on its equipment as a condition of equipment warranty, or as otherwise required to service, repair, adjust, calibrate, or perform work on its equipment.

1. Identify proprietary test equipment, instrumentation, and tools required in the test equipment identification list submittal.
2. Proprietary test equipment, instrumentation, and tools shall become the property of Employer at Taking Over.

2.4 REPORT FORMAT AND ORGANIZATION

A. General Format and Organization:

1. Bind report in three-ring binders.
2. Label the front cover and spine of each binder with the report title, volume number, project name, Contractor's name, and date of report.
3. Record report on compact disk.
4. Electronic Data: Portable document format (PDF); a single file with outline-organized bookmarks for major and minor tabs and tab contents itemized for specific reports.

B. Commissioning Report:

1. Include a table of contents and an index to each test.
2. Include major tabs for each Specification Section.
3. Include minor tabs for each test.
4. Within each minor tab, include the following:

    a. Test specification.
    b. Pre-startup reports.
    c. Approved test procedures.

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d. Test data forms, completed and signed.
e. Commissioning issue reports, showing resolution of issues, and documentation related to resolution of issues pertaining to a single test. Group data forms, commissioning issue reports showing resolution of issues, and documentation related to resolution of issues for each test repetition together within the minor tab, in reverse chronological order (most recent on top).

PART 3 - EXECUTION

3.1 PREPARATION

A. Review preliminary construction checklists and preliminary test procedures and data forms.

3.2 BASIS OF DESIGN DOCUMENTATION

A. Provide documentation of each system design criteria. Include a narrative for each system with its design criteria and design intent.

3.3 DESIGN DOCUMENT REVIEW

A. Provide a complete review of all design documents for commissioning requirements. Provide a sheet by sheet narrative indicating any areas that may prevent a complete and successful commissioning project. Areas of review are:

1. Equipment access and maintainability.
2. Installation clearances and available space.
3. Any specific layout or design problem that will prevent its being commissioned.

3.4 COMMISSIONING PLAN

A. The commissioning plan for this project shall detail the implementation of the commissioning process. The Commissioning Committee will formulate the commissioning plan for the project based on the plans and specifications. This plan will include the following:

1. The initial design intent.
2. A listing of observations and inspections to be made during construction.
3. A listing of the equipment and systems that will be functionally tested.
4. A description of the commissioning documentation.
5. A schedule and sequence to provide documentation.
6. Acceptance procedures.
7. Training requirements.

3.5 CONSTRUCTION CHECKLISTS

A. Construction checklists cannot modify or conflict with the Contract Documents.

B. Create construction checklists based on actual systems and equipment to be included in Project.

C. Material Checks: Compare specified characteristics and approved submittals with materials as received. Include factory tests and other evaluations, adjustments, and tests performed prior to shipment if applicable.

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1. Service connection requirements, including configuration, size, location, and other pertinent characteristics.
2. Included optional features.
3. Delivery Receipt Check: Inspect and record physical condition of materials and equipment on delivery to Project site, including agreement with approved submittals, cleanliness, and lack of damage.
4. Installation Checks:

    a. Location according to Drawings and approved Shop Drawings.
    b. Configuration.
    c. Compliance with manufacturers' written installation instructions.
    d. Attachment to structure.
    e. Access clearance to allow for maintenance, service, repair, removal, and replacement without the need to disassemble or remove other equipment or building elements. Access coordinated with other building elements and equipment, including, but not limited to, ceiling and wall access panels, in a manner consistent with OSHA fall-protection regulations and safe work practices.
    f. Utility connections are of the correct characteristics, as applicable.
    g. Correct labeling and identification.
    h. Startup Checks: Verify readiness of equipment to be energized. Include manufacturer's standard startup procedures and forms.

D. Startup: Perform and document initial operation of equipment to prove that it is installed properly and operates as intended according to manufacturer's standard startup procedures, at minimum.

E. Performance Tests:
1. Static Tests: As specified elsewhere, including, but not limited to, duct and pipe leakage tests, insulation-resistance tests, and water-penetration tests.
2. Ductwork leakage testing must be carried out by a company that is specialized in commissioning of buildings.
3. Component Performance Tests: Tests evaluate the performance of an input or output of components under a full range of operating conditions.
4. Equipment and Assembly Performance Tests: Test and evaluate performance of equipment and assemblies under a full range of operating conditions and loads.
5. System Performance Tests: Test and evaluate performance of systems under a full range of operating conditions and loads.
6. Intersystem Performance Tests: Test and evaluate the interface of different systems under a full range of operating conditions and loads.

F. Deferred Construction Checklists: Obtain Employer’s approval of proposed deferral of construction checklists, including proposed schedule of completion of each deferred construction checklist, before submitting request for Certificate of Construction-Phase Commissioning Process Completion. When approved, deferred construction checklists may be completed after date of Construction-Phase Commissioning Completion. Include the following in a request for Certificate of Construction-Phase Commissioning Process Completion:

1. Identify deferred construction checklists by number and title.
2. Provide a target schedule for completion of deferred construction checklists.
3. Written approval of proposed deferred construction checklists, including approved schedule of completion of each deferred construction checklist.

G. Delayed Construction Checklists: Obtain Employer’s approval of proposed delayed construction checklists, including proposed schedule of completion of each delayed construction checklist, before submitting request for Certificate of Construction-Phase Commissioning Process Completion. When approved, delayed construction checklists may be completed after date of Construction-Phase Commissioning Completion. Include the following in a request for Certificate of Construction-Phase Commissioning Process Completion:

1. Identify delayed construction checklist by construction checklist number and title.

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2. Provide a target schedule for completion of delayed construction checklists.
3. Written approval of proposed delayed construction checklists, including approved schedule of completion of each delayed construction checklist.

3.6 GENERAL EXECUTION REQUIREMENTS

A. Schedule and coordinate commissioning process with the Construction Schedule.

B. Perform activities identified in construction checklists, including tests, and document results of actions as construction proceeds.

C. Perform test demonstrations for Employer's witness. Unless otherwise indicated, demonstrate tests for 100 percent of work to which the test applies. In some instances, demonstration of a random sample of other than 100 percent of the results of a test is specified.
1. On determination of the sample size, the samples shall be selected randomly by Employer's witness at the time of the test demonstration.
2. Include in the Commissioning Plan a detailed list of the test demonstrations with lot and sample quantities for each test.

D. Report test data and commissioning issue resolutions.

E. Schedule personnel to participate in and perform Commissioning-Process Work.

F. Installing Contractors' commissioning responsibilities include, but are not limited to, the following:

1. Operating the equipment and systems they install during tests.
2. In addition, installing contractors may be required to assist in tests of equipment and systems with which their work interfaces.

3.7 COMMISSIONING COORDINATOR RESPONSIBILITIES

A. Management and Coordination: Manage, schedule, and coordinate commissioning process, including, but not limited to, the following:

1. Coordinate with subcontractors on their commissioning responsibilities and activities.
2. Obtain, assemble, and submit commissioning documentation.
3. Conduct periodic on-site commissioning meetings. Comply with requirements in Section 013100 "Project Management and Coordination."
4. Develop and maintain the commissioning schedule. Integrate commissioning schedule into the Construction Schedule. Update Construction Schedule at specified intervals.
5. Review and comment on preliminary test procedures and data forms.
6. Report inconsistencies and issues in system operations.
7. Verify that tests have been completed and results comply with acceptance criteria, and that equipment and systems are ready before scheduling test demonstrations.
8. Direct and coordinate test demonstrations.
9. Coordinate witnessing of test demonstrations by Employer's witness.
10. Coordinate and manage training. Be present during training sessions to direct video recording, present training, and direct the training presentations of others. Comply with requirements in Section 017900 "Demonstration and Training."
11. Prepare and submit specified commissioning reports.
12. Track commissioning issues until resolution and retesting is successfully completed.
13. Retain original records of Commissioning-Process Work, organized as required for the commissioning report. Provide Employer's representative access to these records on request.
14. Assemble and submit commissioning report.

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3.8 COMMISSIONING TESTING

A. Quality Control: Construction checklists, including tests, are quality-control tools designed to improve the functional quality of Project. Test demonstrations evaluate the effectiveness of Contractor's quality-control process.

B. Employer’s witness will be present to witness commissioning work requiring the signature of an Employer's witness, including, but not limited to, test demonstrations. Employer's project manager will coordinate attendance by Employer's witness with Contractor's published Commissioning Schedule. Employer's witness will provide no labor or materials in the commissioning work. The only function of Employer's witness will be to observe and comment on the progress and results of commissioning process.

C. Construction Checklists:

1. Complete construction checklists as Work is completed.
2. Distribute construction checklists to installing contractors before they start work.
3. Installers:

    a. Verify installation using approved construction checklists as Work proceeds.
    b. Complete and sign construction checklists daily for work performed during the preceding day.

4. Provide Commissioning Authority access to construction checklists.

D. Installation Compliance Issues: Record as an installation compliance issue Work found to be incomplete, inaccessible, at variance with the Contract Documents, nonfunctional, or that does not comply with construction checklists. Record installation compliance issues on the construction checklist at the time they are identified. Record corrective action and how future Work should be modified before signing off the construction checklist.

E. Pre-Startup Audit: Prior to executing startup procedures, review completed installation checks to determine readiness for startup and operation. Report conditions, which, if left uncorrected, adversely impact the ability of systems or equipment to operate satisfactorily or to comply with acceptance criteria. Prepare pre-startup report for each system.

F. Test Procedures and Test Data Forms:

1. Test procedures shall define the step-by-step procedures to be used to execute tests and test demonstrations.
2. Test procedures shall be specific to the make, model, and application of the equipment and systems being tested.
3. Completed test data forms are the official records of the test results.
4. Commissioning Authority will provide to Contractor preliminary test procedures and test data forms for performance tests and commissioning tests after approval of Product Data, Shop Drawings, and preliminary operation and maintenance manual.
5. Review preliminary test procedures and test data forms, and provide comments within 14 days of receipt from Commissioning Authority. Review shall address the following:

    a. Equipment protection and warranty issues, including, but not limited to, manufacturers' installation and startup recommendations, and operation and maintenance instructions.
    b. Applicability of the procedure to the specific software, equipment, and systems approved for installation.

6. After Contractor has reviewed and commented on the preliminary test procedures and test data forms, Commissioning Authority will revise and reissue the approved revised test procedures and test data forms marked "Approved for Testing."

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7. Use only approved test procedures and test data forms marked "Approved for Testing" to perform and document tests and test demonstrations.

G. Performance of Tests:

1. The sampling rate for tests is 100 percent. The sampling rate for test demonstrations is 100 percent unless otherwise indicated.
2. Perform and complete each step of the approved test procedures in the order listed.
3. Record data observed during performance of tests on approved data forms at the time of test performance and when the results are observed.
4. Record test results that are not within the range of acceptable results on commissioning issue report forms in addition to recording the results on approved test procedures and data forms according to the "Commissioning Compliance Issues" Paragraph in this Article.
5. On completion of a test, sign the completed test procedure and data form. Tests for which test procedures and data forms are incomplete, not signed, or which indicate performance that does not comply with acceptance criteria will be rejected. Tests for which test procedures and data forms are rejected shall be repeated and results resubmitted.

H. Performance of Test Demonstration:

1. Perform test demonstrations on a sample of tests after test data submittals are approved. The sampling rate for test demonstrations shall be 100 percent unless otherwise indicated in the individual test specification.
2. Notify Employer's witness at least three days in advance of each test demonstration.
3. Perform and complete each step of the approved test procedures in the order listed.
4. Record data observed during performance of test demonstrations on approved data forms at the time of demonstration and when the results are observed.
5. Provide full access to Employer's witness to directly observe the performance of all aspects of system response during the test demonstration. On completion of a test demonstration, sign the completed data form and obtain signature of Employer's witness at the time of the test to authenticate the reported results.
6. Test demonstration data forms not signed by Contractor and Employer's witness at the time of the completion of the procedure will be rejected. Test demonstrations for which data forms are rejected shall be repeated and results shall be resubmitted.

    a. Exception for Failure of Employer's Witness to Attend: Failure of Employer's witness to be present for agreed-on schedule of test demonstration shall not delay Contractor. If Employer's witness fails to attend a scheduled test, Contractor shall proceed with the scheduled test. On completion, Contractor shall sign the data form for Contractor and for Employer's witness, and shall note the absence of Employer's witness at the scheduled time and place.

7. False load test requirements are specified in related Sections.

    a. Where false load testing is specified, provide temporary equipment, power, controls, wiring, piping, valves, and other necessary equipment and connections required to apply the specified load to the system. False load system shall be capable of steady-state operation and modulation at the level of load specified. Equipment and systems permanently installed in this work shall not be used to create the false load without Engineer's written approval.

I. Deferred Tests:

1. Deferred Test List: Identify, in the request for Certificate of Construction-Phase Commissioning Process Completion, proposed deferred tests or other tests approved for deferral until specified seasonal or other conditions are available. When approved, deferred tests may be completed after the date of Construction-Phase Commissioning Completion. Identify proposed deferred tests in the request for Certificate of Construction-Phase Commissioning Process Completion as follows:

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a. Identify deferred tests by number and title.
b. Provide a target schedule for completion of deferred tests.

2. Schedule and coordinate deferred tests. Schedule deferred tests when specified conditions are available. Notify Engineer and Commissioning Authority at least three working days (minimum) in advance of tests.
3. Where deferred tests are specified, coordinate participation of necessary personnel and of Engineer, Commissioning Authority, and Employer's witness. Schedule deferred tests to minimize occupant and facility impact. Obtain Engineer's approval of the proposed schedule.

J. Delayed Tests:

1. Delayed Test List: Identify, in the request for Certificate of Construction-Phase Commissioning Process Completion, proposed delayed tests. Obtain Employer approval of proposed delayed tests, including proposed schedule of completion of each delayed test, before submitting request for Certificate of Construction-Phase Commissioning Process Completion. Include the following in the request for Certificate of Construction-Phase Commissioning Process Completion:

a. Identify delayed tests by test number and title.
b. Written approval of proposed delayed tests, including approved schedule of completion of delayed tests.

2. Schedule and coordinate delayed tests. Schedule delayed tests when conditions that caused the delay have been rectified. Notify Engineer and Commissioning Authority at least three working days (minimum) in advance of tests.
3. Where delayed tests are approved, coordinate participation of necessary personnel and of Engineer, Commissioning Authority, and Employer's witness. Schedule delayed tests to minimize occupant and facility impact. Obtain Engineer's approval of the proposed schedule.

K. Commissioning Compliance Issues:

1. Test results that are not within the range of acceptable results are commissioning compliance issues.
2. Track and report commissioning compliance issues until resolution and retesting are successfully completed.
3. If a test demonstration fails, determine the cause of failure. Direct timely resolution of issue and then repeat the demonstration. If a test demonstration must be repeated due to failure caused by Contractor work or materials, reimburse Employer for billed costs for the participation in the repeated demonstration.
4. Test Results: If a test demonstration fails to meet the acceptance criteria, perform the following:

a. Complete a commissioning compliance issue report form promptly on discovery of test results that do not comply with acceptance criteria.
b. Submit commissioning compliance issue report form within 24 hours of the test.
c. Determine the cause of the failure.
d. Establish responsibility for corrective action if the failure is due to conditions found to be Contractor's responsibility.

5. Commissioning Compliance Issue Report: Provide a commissioning compliance issue report for each issue. Do not report multiple issues on the same commissioning compliance issue report.

a. Exception: If an entire class of devices is determined to exhibit the identical issue, they may be reported on a single commissioning compliance issue report. (For example, if all return-air damper actuators that are specified to fail to the open position are found to fail to the closed position, they may be reported on a single commissioning issue report. If a single commissioning issue report is used for

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multiple commissioning compliance issues, each device shall be identified in the report, and the total number of devices at issue shall be identified.

b. Complete and submit Part 1 of the commissioning compliance issue report immediately when the condition is observed.
c. Record the commissioning compliance issue report number and describe the deficient condition on the data form.
d. Resolve commissioning compliance issues promptly. Complete and submit Part 2 of the commissioning compliance issue report when issues are resolved.

6. Diagnose and correct failed test demonstrations as follows:

a. Perform diagnostic tests and activities required to determine the fundamental cause of issues observed.
b. Record each step of the diagnostic procedure prior to performing the procedure. Update written procedure as changes become necessary.
c. Record the results of each step of the diagnostic procedure.
d. Record the conclusion of the diagnostic procedure on the fundamental cause of the issue.
e. Determine and record corrective measures.
f. Include diagnosis of fundamental cause of issues in commissioning compliance issue report.

7. Retest:

a. Schedule and repeat the complete test procedure for each test demonstration for which acceptable results are not achieved. Obtain signature of Employer's witness on retest data forms. Repeat test demonstration until acceptable results are achieved. Except for issues that are determined to result from design errors or omissions, or other conditions beyond Contractor's responsibility, compensate Employer for direct costs incurred as the result of repeated test demonstrations to achieve acceptable results.
b. For each repeated test demonstration, submit a new test data form, marked "Retest."

8. Do not correct commissioning compliance issues during test demonstrations.

a. Exceptions will be allowed if the cause of the issue is obvious and resolution can be completed in less than five minutes. If corrections are made under this exception, note the deficient conditions on the test data form and issue a commissioning compliance issue report. A new test data form, marked "Retest," shall be initiated after the resolution has been completed.

3.9 COMMISSIONING MEETINGS

A. Schedule and conduct commissioning meetings. Comply with requirements in Section 013100 "Project Management and Coordination."

B. The commissioning scoping meeting is planned and called for by the Contractor’s Commissioning Manager of the Commissioning Committee within 90 days of the beginning of construction. It is obligatory that the Engineer and the designer’s, sub-contractors/suppliers assigned by the Contractor be invited. During the meeting, parties; including but not limited to the Employer, Engineer, Contractor and his Sub-contractors and suppliers, involved in the commissioning shall be introduced and the commissioning process shall be reviewed, while management and reporting lines shall be determined. The flow of documents, how much submittal data the Commissioning Committee (Team) will receive, etc. shall also be discussed.

C. The outline of the commissioning plan shall be prepared by the Contractor’s Commissioning Committee and shall be reviewed by the Engineer. The commissioning plan shall address process questions. Lines of reporting and communications shall be determined and the work products list shall be discussed. Also, to be covered is the general list of each party’s responsibilities; who is

responsible to develop the startup plan for each piece of equipment, assembly and system; and the proposed commissioning schedule.

D. The outcome of the meeting should result in an increased understanding by all parties of the commissioning process and their respective responsibilities. The meeting provides the Commissioning Committee additional information needed to finalize the Commissioning Plan, including the commissioning schedule.

E. Prior to this meeting the attendees shall receive from the Contractor, all drawings, specifications and the construction schedule. The Commissioning Committee shall keep notes of the meeting and shall distribute them to the attendees.

F. Other meetings will be planned and called for by the Contractor's Commissioning Manager as construction progresses. Those meetings will cover coordination, deficiency resolution and planning issues with particular Sub-contractors. The Commissioning Committee will plan those meetings and will minimize unnecessary time being spent by Sub-contractors and suppliers. Those meetings will be held every two weeks, until the final 6 months of construction when they will be held as frequently as one per week or more.

G. Minutes of such meetings shall be submitted to the Engineer for information.

H. The Engineer shall be free to call meetings upon the above subject as and when he considers such meetings are required. The Contractor's Commissioning Committee and any other representatives of the Contractor or the sub-contractors and suppliers invited shall attend as summoned.

3.10 SEQUENCING

A. Sequencing of Commissioning Verification Activities: For a particular material, item of equipment, assembly, or system, perform the following in the order listed unless otherwise indicated:

1. Construction Checklists:

    a. Material checks.
    b. Installation checks.
    c. Startup, as appropriate. Some startup may depend on component performance. Such startup may follow component performance tests on which the startup depends.
    d. Performance Tests:

        1) Static tests, as appropriate.
        2) Component performance tests. Some component performance tests may depend on completion of startup. Such component performance tests may follow startup.
        3) Equipment and assembly performance tests.
        4) System performance tests.
        5) Intersystem performance tests.

2. Commissioning tests.

B. Before performing commissioning tests, verify that materials, equipment, assemblies, and systems are delivered, installed, started, and adjusted to perform according to construction checklists.

C. Verify readiness of materials, equipment, assemblies, and systems by performing tests prior to performing test demonstrations. Notify Engineer if acceptable results cannot be achieved due to conditions beyond Contractor's control or responsibility.

D. Commence tests as soon as installation checks for materials, equipment, assemblies, or systems are satisfactorily completed. Tests of a particular system may proceed prior to completion of other systems, provided the incomplete work does not interfere with successful execution of test.

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3.11 SCHEDULING

A. Commissioning of systems will proceed per the commissioning schedule and as outlined in the commissioning plan, The Contractor's Commissioning Committee (Team) will work and schedule the commissioning activities which shall be subject to the approval of the Engineer. Commissioning schedule shall be arranged in a form to be agreed upon with the Engineer Commissioning schedule shall include by no way of limitation the following details:

1. Scoping meeting and final plan
2. Commissioning submittals
3. Construction site visits and meetings
4. Pre-functional checklists/tests (Write & distribute)
5. Startup and initial checkout plan
6. Startup and initial checkout (pre-functional)
7. Functional performance tests
8. Manual Tests Execution
9. Documentation Verification
10. Final Commissioning Report
11. Seasonal testing

The above-mentioned activities are only for guidance. Details of actions under each task and duration is to be indicated with duration.

B. The Contractor shall coordinate with his Commissioning Committee (team) and integrate all commissioning activities within his design and construction programme of the Contract.

C. The Contractor's Commissioning Committee shall address scheduling problems and make necessary notifications, updating, revisions, in a timely manner in order to expedite the commissioning process.

D. The Commissioning Committee (team) shall provide the initial schedule of primary commissioning events with the estimated start and end date for each event at the commissioning scoping meeting, which shall be held at the start of the work to coordinate the different commissioning activities. Commissioning events with the estimated start and end date for each event shall be arranged in a form to be agreed upon with Engineer, Initial Commissioning Schedule Summary shall include by no way of limitation the following events/activities:

1. Task/Activity
2. Initial scooping meeting and final plan
3. Submittals obtained and reviewed
4. Begin construction site visits/inspections
5. Pre-functional forms developed and distributed
6. Start-up and initial checkout plans
7. Start-up and initial checkout executed
8. Functional performance tests
9. O&M documentation review and verification
10. Final commissioning report
11. Seasonal testing

E. As construction progresses more detailed schedules are to be developed by the Commissioning Committee (team).

F. Commence commissioning process as early in the construction period as possible.

G. Commissioning Schedule: Integrate commissioning activities into Construction Schedule. See Section 013200 "Construction Progress Documentation."

1. Include detailed commissioning activities in monthly updated Construction Schedule and short-interval schedule submittals.
2. Schedule the start date and duration for the following commissioning activities:

    a. Submittals.
    b. Preliminary operation and maintenance manual submittals.
    c. Installation checks.
    d. Startup, where required.
    e. Performance tests.
    f. Performance test demonstrations.
    g. Commissioning tests.
    h. Commissioning test demonstrations.

3. Schedule shall include a line item for each installation check, startup, and test activity specific to the equipment or systems involved.
4. Determine milestones and prerequisites for commissioning process. Show commissioning milestones, prerequisites, and dependencies in monthly updated critical-path-method construction schedule and short-interval schedule submittals.

H. Two-Week Look-Ahead Commissioning Schedule:

1. Two weeks prior to the beginning of tests, submit a detailed two-week look-ahead schedule. Thereafter, submit updated two-week look-ahead schedules weekly for the duration of commissioning process.
2. Two-week look-ahead schedules shall identify the date, time, beginning location, Contractor personnel required, and anticipated duration for each startup or test activity.
3. Use two-week look-ahead schedules to notify and coordinate participation of Employer’s witnesses.

I. Employer’s Witness Coordination:

1. Coordinate Employer's witness participation via Engineer.
2. Notify Engineer of commissioning schedule changes at least two work days in advance for activities requiring the participation of Employer's witness.

3.12 COMMISSIONING PROCESS

A. The following narrative provides a brief overview of the typical commissioning tasks of the project and the general order in which they occur.

1. Commissioning begins with the scoping meeting called by the Contractor’s Commissioning Committee manager and/or the Engineer, where the commissioning process is reviewed with the commissioning parties.
2. The Commissioning Committee finalizes the commissioning plan using the information gathered from the scoping meeting. The initial commissioning schedule is also developed, along with detailed time line using *Detailed Commissioning Schedule,* the form of which shall be agreed upon with Engineer.
3. Additional meetings will be required throughout construction, scheduled by the Commissioning Committee and/or the Engineer, with necessary parties attending, to plan, scope, coordinate, schedule future activities and resolve problems.
4. Equipment documentation is to be copied by the Contractor to his Commissioning Committee during normal submittals, including detailed start-up procedure.

5. The Commissioning Committee shall work together with the Sub-contractors/suppliers/vendors to develop start-up plans and start-up documentation formats, including providing the Sub-contractors with pre-functional checklists to be completed, during the start-up process.
6. In general, checkout and performance verification proceeds from simple to complex, from component level to equipment to systems and intersystem integration levels. Pre-functional checklists shall be completed before functional testing.
7. The Sub-contractors, under their own direction shall execute and document the pre-functional checklists and perform start-up and initial checkout. The Commissioning Committee shall review and document that the checklists and start-up were completed according to the approved plans. This will include the Commissioning Committee, Employer and Engineer witnessing start-up of selected equipment.
8. The Commissioning Committee develops specific equipment and system integration functional performance test procedures. All documents shall be submitted for approval to the Engineer prior to any actions having been taken.
9. The procedures are executed by the Contractor/Sub-contractors, under the direction of, and documented by the Commissioning Committee. All shall be subject approval of the Engineer
10. Items of non-compliance in material, installation or setup shall be corrected at the Contractor's expense prior to retesting of the system concerned.
11. The Commissioning Committee reviews the O&M documentation for completeness.
12. Deferred testing is conducted, as specified or required.

3.13 START-UP CHECKLIST AND INITIAL CHECKOUT

The following procedures shall apply to all equipment and systems to be commissioned.

A. General: Pre-functional checklists are important to ensure that the equipment and systems are hooked up and operational. It ensures that functional performance testing (in-depth system checkout) may proceed without unnecessary delays. Each piece of equipment receives full pre-functional checkout. No sampling strategies are used. The pre-functional testing for a given system must be successfully completed prior to formal functional performance testing of equipment or subsystems of the given system.

B. Start-up and Initial Checkout Plan: The Commissioning Committee shall assist the commissioning parties responsible for startup of any equipment in developing detailed start-up plans for all equipment. The primary role of the Commissioning Committee in this process is to ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed and that such documentation has been submitted and approved by the Engineer prior to being needed on site.

1. The Commissioning Committee shall prepare pre-functional checklists and procedures that include safety requirements using Form to be agreed upon with the Engineer and involved parties such form is related to Plan *and Documentation Requirements for Startup and Initial Checkout*. Those checklists indicate and define the required procedures to be executed as part of startup and initial checkout of the systems. They also define the party responsible for the execution of startup/initial checkout.

2. The Contractor or his sub-contractor/supplier/vendor responsible for the purchase and installation of the equipment shall develops the full start-up plan by combining (or adding to) the Commissioning Committee's checklists with the manufacturer's detailed start-up and checkout procedures from the O&M manual and the normally used field checkout sheets. The plan will include checklists and procedures with specific boxes or lines for recording and documenting the execution of checking and inspection and a summary statement with a signature block at the end of the plan. The Commissioning Committee shall ensure that all such checkout sheets are submitted for approval by the Engineer well in advance of the time that they will be need on site.

3. The full start-up plan shall mainly consist of:

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a. The Commissioning Committee's pre-functional checklists.
b. The manufacturer's standard written start-up procedures copies from the installation manuals with check boxes by each procedure and signature block added by hand at the end.
c. The manufacturer's normally used field checkout sheets.
d. The Contractor/sub-contractor submit the full startup plan to the Commissioning Committee for review updating and comments ready for submission for approval.
e. The Commissioning Committee reviews the procedures and format for documenting them, noting any procedures that need to be added and then submits for Construction Manger approval.

C. Execution of Pre-functional Checklists and Startup:

1. Four weeks prior to startup, Contractor shall schedule, in coordination with the Sub-contractors and vendors, startup and checkout with the Engineer, Employer, Contractor's design team and Commissioning Committee. The performance of the pre-functional checklists, startup and checkout will be directed and executed by the Contractor/Sub-contractors or vendor.

   When checking off pre-functional checklists, signatures may be required of other Sub-contractors or vendors/suppliers/installers for verification of completion of their work.

   All original records produced by the said procedures will be organized and submitted to the Engineer for the records of the project. The Commissioning Committee shall on behalf of the Contractor maintain organized and full electronic copies of all such documents.

2. The Commissioning Committee shall observe, the procedures for each piece of primary equipment, unless there are multiple units, (in which case a sampling strategy may be used as approved by the Engineer).

   In no case will the number of units witnessed be less than four on any one system, nor less than 20% of the total number of identical or very similar units.

3. The Contractor's Sub-contractors and vendors shall execute startup and provide the Contractor's Commissioning Committee with a signed and dated electronic copy of the completed start-up and pre-functional tests and checklists. The Commissioning Committee shall do likewise with the Engineer.

D. Deficiencies, Non-Conformance and Approval in Checklists and Startup:

1. The Contractor with his Sub-contractors shall clearly list any outstanding items of the initial start-up and pre-functional procedures that were not completed successfully, at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies shall be provided to the Contractor's Commissioning Committee within one working day of test completion with a copy to the Engineer for information.

2. The Commissioning Committee shall review and submit on behalf of the Contractor, with any comments that the Commissioning Committee may have, the procedures form and any outstanding deficiencies, to the Engineer. The Engineer shall issue a non-compliance report or an approval form to the Contractor.

3. The Commissioning Committee shall work with the Sub-contractors and vendors to correct and retest deficiencies or uncompleted items. In this respect the Commissioning Committee will report to the Engineer and others as necessary. The Contractor/Installing Sub-contractors or vendors shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner, and shall notify the Commissioning Committee as soon as outstanding items have been corrected and resubmit an updated start-up report and a Statement of Correction on the original non-compliance report. When satisfactory completed, the Commissioning

Committee recommends approval of the execution of the checklists and startup of each system to the Engineer using Form agreed upon related Commissioning Test or Document Approval.

4. Items left incomplete, which later cause deficiencies or delays during functional testing, may result in back-charges to the responsible party.

3.14 FUNCTIONAL PERFORMANCE TESTING

A. General: The objective of functional performance testing is to demonstrate that each system is operating according to the documented design intent and Contract Documents. Functional testing facilitates bringing the systems from a state of substantial completion to full dynamic operation. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems. In general, each system should be operated through all modes of operation. Inter-system integration performance shall further be tested and checked.

B. Development of Test Procedure: Before test procedures are written, the Commissioning Committee shall obtain all requested documentation and a current list of change orders affecting equipment or systems from the Contractor, such as an updated points list, program code, control sequences and parameters. The Commissioning Committee shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Each Sub-contractor or vendor responsible to execute a test shall provide all assistance to the Commissioning Committee in developing the procedures review (answering questions about equipment, operation, sequences, etc.)

Prior to execution, the Commissioning Committee shall provide a copy of the test procedures to the Sub-contractors who shall review the tests for feasibility, safety, equipment and warranty protection. The Commissioning Committee shall submit the test procedure to the Engineer for review and approval.

The purpose of any given specific test is to verify document compliance with the stated criteria of acceptance given in the test form.

The test procedure electronic forms developed by the Commissioning Committee shall include (but not limited to) the following information:

1. System, equipment or component name(s).
2. Equipment location and ID number.
3. Unique test ID number and reference to unique pre-functional checklist and start-up documentation ID numbers for the piece of equipment.
4. Date.
5. Project name.
6. Participating parties.
7. A copy of the relevant specification describing the test requirements.
8. A copy of the specific sequence of operations or other specified parameters being verified.
9. Formulas used in any calculations.
10. Required pre-test field measurements.
11. Instructions for setting up the test.
12. Special cautions, alarm limits, etc.
13. Specific step-by-step procedures to execute the test, in a clear, sequential and repeatable format.
14. Acceptance criteria of proper performance with a Yes/No check box to allow for clearly making whether or not proper performance of each part of the test was achieved.

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15. A section for comments.
16. Signatures and date block for the Engineer.

C. Coordination and Scheduling: The Sub-contractors provide sufficient notice to the Commissioning Committee regarding their completion schedule for the pre-functional checklists and startup of all equipment and systems. The Commissioning Committee will schedule functional tests through the Engineer and the affected Sub-contractors. The Commissioning Committee shall direct, witness, along with the Engineer, and document the functional testing of all equipment and systems. The Sub-contractors shall execute the tests. The Commissioning Committee shall on behalf of the Contractor submit all test records to the Engineer for approval.

In general, functional testing is conducted after pre-functional and startup has been satisfactorily completed.

Testing shall proceed from components to assemblies to subsystems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated response between systems is checked.

3.15 DOCUMENTATION, NON-CONFORMANCE AND TEST APPROVAL

A. Documentation: The Commissioning Committee shall witness, along with the Engineer, and document the results of all functional performance tests using the specific procedural forms developed for that purpose. Prior to testing, the forms are provided to the Engineer for review and approval and to the Contractor/Sub-contractors for review. The Commissioning Committee will include he filled out and approved forms in the O&M manuals.

B. Non-Conformance:

1. The Commissioning Committee will record the results of the functional test on the procedure or test form. All deficiencies or non-conformance issues shall be noted and reported to the Engineer on a standard non-compliance form.
2. Corrections of minor deficiencies identified may be made during the tests at the discretion of the Engineer. In such cases the deficiency and resolution will be documented on the procedure form.
3. The Commissioning Committee records the results of the test on the procedure or test form. Deficiencies or non-conformance issue are noted to the Engineer on Form (Commissioning Corrective Action Report). Contractor/Sub-contractors correct deficiencies, notify the Commissioning Committee and return Form certifying corrections. The Commissioning Committee shall schedule retesting through the Engineer.
4. Every effort shall be made to expedite the testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the Engineer will not overlook deficient work or relax acceptance criteria to satisfy scheduling or cost issues.
5. As tests progress and a deficiency are identified, the Commissioning Committee discusses the issue with the executing sub-contractor, and advises the Engineer of the conclusions reached.
6. When there is no dispute on the deficiency and the Contractor/Sub-contractor accepts responsibility to correct it:

    a. The Commissioning Committee documents the deficiency and the Contractor's /Sub-contractor response and intention and they go on to another test or sequence. After the day's work, the Commissioning Committee submits the non-compliance reports to the Engineer. An electronic copy is provided to the Sub-contractor. The Sub-contractor shall correct the deficiency, signs the statement of correction at the bottom of the non-compliance form certifying that the equipment is ready to be retested and send it back to the Commissioning Committee who will copy to the Engineer.

    b. The Commissioning Committee shall accordingly reschedule the test in conjunction with the Engineer and the test shall be repeated.

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7. If there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:

    a. The deficiency shall be documented on the non-compliance form with the Sub-contractor response and an electronic copy given to the Engineer and to the Sub-contractors representative assumed to be responsible.
    b. Resolutions shall be normally made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive authority is with the Engineer. Final acceptance authority is likewise the Engineer.
    c. The Commissioning Committee shall document the resolution process and shall copy all such documentation to the Engineer.
    d. Once the interpretation and resolution have been decided, the appropriate party shall correct the deficiency, sign the statement of correction on the non-compliance form and provide it to the Commissioning Committee. The Commissioning Committee will reschedule the test and the test shall be repeated in the presence of the Engineer until satisfactory performance is achieved.

8. The Contractor/Commissioning Committee shall report to the Engineer in writing, at least as often as commissioning meetings are being scheduled, concerning the status of each apparent outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreements and proposals for their resolution.
9. The Commissioning Committee retains electronic copies and updated records of all non-conformance forms till the end of the contract.
10. Any required retesting, by any of Contractor's Sub-contractor, shall not be justification for a claim of delay or for a time extension by the Contractor (Sub-contractor or Contractor).

C. Approval of Tests: The Commissioning Committee shall note each satisfactorily function on the test form. Formal approval of the test shall be made later after review by the Engineer. While the Commissioning Committee may recommend acceptance of each test to the Engineer, using standard forms, the final decision as to acceptance rests with the Engineer. The Engineer shall give final approval on each test using the same form, providing a signed electronic copy to the Commissioning Committee and Contract.

3.16 COMMISSIONING REPORTS

A. The Contractor's Commissioning Manager will provide regular reports to the Engineer, with copies to the relevant involved sub-contractors and suppliers, with increasing frequency as construction progresses.

    1. The Contractor's Commissioning Manager will regularly communicate with all commissioning parties, keeping them updated of commissioning progress and scheduling changes through memos, progress reports. Commissioning Committee will keep a log of all commissioning related issue that require current or future attention using forms related to Commissioning Issue Log, Commissioning Progress Record, provides a form from tracking the status of documentation and testing for each piece of equipment and system. All related forms will be agreed upon with Engineer.

B. Test Reports:

    1. Pre-startup reports include observations of the conditions of installation, organized into the following Sections:

        a. Equipment Model Verification: Compare contract requirements, approved submittals, and provided equipment. Note inconsistencies.
        b. Preinstallation Physical Condition Checks: Observe physical condition of equipment prior to installation. Note conditions including, but not limited to, physical damage, corrosion, water damage, or other contamination or dirt.

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c. Preinstallation Component Verification Checks: Verify components supplied with the equipment, preinstalled or field installed, are correctly installed and functional. Verify external components required for proper operation of equipment correctly installed and functional. Note missing, improperly configured, improperly installed, or nonfunctional components.
d. Summary of Installation Compliance Issues and Corrective Actions: Identify installation compliance issues and the corrective actions for each. Verify that issues noted have been corrected.
e. Evaluation of System Readiness for Startup: For each item of equipment for each system for which startup is anticipated, document in summary form acceptable to Employer completion of equipment model verification, preinstallation physical condition checks, preinstallation component verification checks, and completion of corrective actions for installation compliance issues.

2. Test data reports include the following:

a. "As-tested" system configuration. Complete record of conditions under which the test was performed, including, but not limited to, the status of equipment, systems, and assemblies; temporary adjustments and settings; and ambient conditions.
b. Data and observations, including, but not limited to, data trend logs, recorded during the tests.
c. Signatures of individuals performing and witnessing tests.
d. Data trend logs accumulated overnight from the previous day of testing.

3. Commissioning Compliance Issue Reports: Report as commissioning compliance issues results of tests and test demonstrations that do not comply with acceptance criteria. Report only one issue per commissioning compliance issue report. Use sequentially numbered facsimiles of commissioning compliance issue report form included in this Section, or other form approved by Employer. Distribute commissioning compliance issue reports to parties responsible for taking corrective action. Identify the following:

a. Commissioning compliance issue report number. Assign unique, sequential numbers to individual commissioning compliance issue reports when they are created, to be used for tracking.
b. Action distribution list.
c. Report date.
d. Test number and description.
e. Equipment identification and location.
f. Briefly describe observations about the performance associated with failure to achieve acceptable results. Identify the cause of failure if apparent.
g. Diagnostic procedure or plan to determine the cause (include in initial submittal)
h. Diagnosis of fundamental cause of issues as specified below (include in resubmittal).
i. Fundamental cause of unacceptable performance as determined by diagnostic tests and activities.
j. When issues have been resolved, update and resubmit the commissioning issue report forms by completing Part 2. Identify resolution taken and the dates and initials of the persons making the entries.
k. Schedule for retesting.

4. Weekly progress reports include information for tests conducted since the preceding report and the following:

a. Completed data forms.
b. Equipment or system tested, including test number, system or equipment tag number and location, and notation about the apparent acceptability of results.
c. Activities scheduled but not conducted per schedule.
d. Commissioning compliance issue report log.
e. Schedule changes for remaining Commissioning-Process Work, if any.

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5. Data trend logs shall be initiated and running prior to the time scheduled for the test demonstration.

    a. Trend log data format shall be multiple data series graphs. Where multiple data series are trend logged concurrently, present the data on a common horizontal time axis. Individual data series may be presented on a segmented vertical axis to avoid interference of one data series with another, and to accommodate different axis scale values. Graphs shall be sufficiently clear to interpret data within the accuracy required by the acceptance criteria.
    b. Attach to the data form printed trend log data collected during the test or test demonstration.
    c. Record, print out, and attach to the data form operator activity during the time the trend log is running. During the time the trend log is running, operator intervention not directed by the test procedure invalidates the test results.

6. System Alarm Logs: Record and print out a log of alarms that occurred since the last log was printed. Evaluate alarms to determine if the previous day's work resulted in any conditions that are not considered "normal operation."

    a. Conditions that are not considered "normal operation" shall be reported on a commissioning issue report attached to the alarm log. Resolve as necessary. The intent of this requirement is to discover control system points or sequences left in manual or disabled conditions, equipment left disconnected, set points left with abnormal values, or similar conditions that may have resulted from failure to fully restore systems to normal, automatic control after test completion.

C. FINAL COMMISSIONING REPORT

1. A final commissioning report by the Commissioning Committee will be provided to the Engineer for his approval. The report shall include an executive summary, list of participants and roles, brief systems description, overview of commissioning and testing scope and a general description of testing and verification methods. For each piece of commissioned equipment or system, the report should contain the disposition of the commissioning team regarding the adequacy of the equipment and documentation according to contract documents in the following areas:

    a. Equipment/System meeting its specifications.

    b. Equipment/System installation.

    c. Functional performance and efficiency.

    d. Equipment/System documentation and design intent.

2. Each non-compliance issue shall be referenced to the specific functional test, inspection, trend log, etc. where the deficiency is documented. The functional performance and efficiency section for each piece of equipment shall include a brief description of the verification method and include observations and conclusions from the testing.

3. Appendices shall contain acquired sequence documentation, logs, meeting minutes, progress reports, deficiency lists, site visit reports, findings, unresolved issues, communications, etc. Pre-functional checklists and functional tests and monitoring data and analysis will be provided in a separate labeled binder.

4. For each group of integrated systems, a final similar report shall be also provided by the Commissioning Committee. The report of each group shall mainly include:

5. System Integration documentation/design intent.

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6. Functional integration performance of all systems.

D. WRITTEN WORK PRODUCT

1. The commissioning process generates a number of written work products.

In summary the written products are:

Product	Developed By	Approved By
- Final commissioning plan	Commissioning Committee	Engineer
- Meeting minutes	Commissioning Committee	Engineer
- Commissioning schedules	Contractor/Commissioning Committee and Engineer	Engineer
- Equipment submittals	Sub-contractors/Contractor /Commissioning Committee	Engineer
- Sequence clarifications	Sub-contractors and Engineer as needed	Engineer
- Pre-functional checklists	Commissioning Committee	Engineer
- Startup & initial checkout plan	Sub-contractors/Contractor /Commissioning Committee	Engineer
- Startup & initial checkout forms filled out	Sub-contractors/Contractor	Engineer
- Issues log (deficiencies)	Commissioning Committee	Engineer
- Commissioning Progress Record	Commissioning Committee	Engineer
- Deficiency reports	Commissioning Committee	Engineer
- Functional test forms	Commissioning Committee	Engineer
- Filled out functional tests	Commissioning Committee	Engineer
- O&M manuals	Sub-contractors/Contractor /Commissioning Committee	Engineer
- Commissioning record book	Commissioning Committee	Engineer
- Final commissioning report	Commissioning Committee	Engineer
- Misc. approvals	Commissioning Committee	Engineer

3.17 CERTIFICATE OF CONSTRUCTION-PHASE COMMISSIONING PROCESS COMPLETION

A. When Contractor considers that construction-phase commissioning process, or a portion thereof which Employer agrees to accept separately, is complete, Contractor shall prepare and submit to Employer and Commissioning Authority through Engineer a comprehensive list of items to be completed or corrected. Failure to include an item on such list does not alter Contractor's responsibility to compete commissioning process.

B. On receipt of Contractor's list, Commissioning Authority will make an inspection to determine whether the construction-phase commissioning process or designated portion thereof is complete. If

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Commissioning Authority's inspection discloses items, whether included on Contractor's list, which is not sufficiently complete as defined in "Construction-Phase Commissioning Process Completion" Paragraph in the "Definitions" Article, Contractor shall, before issuance of the Certificate of Construction-Phase Commissioning Process Completion, complete or correct such items on notification by Commissioning Authority. In such case, Contractor shall then submit a request for another inspection by Commissioning Authority to determine construction-phase commissioning process completion.

C. Contractor shall promptly correct deficient conditions and issues discovered during commissioning process. Costs of correcting such deficient conditions and issues, including additional testing and inspections, the cost of uncovering and replacement, and compensation for Engineer's and Commissioning Authority's services and expenses made necessary thereby, shall be at Contractor's expense.

D. When construction-phase commissioning process or designated portion is complete, Commissioning Authority will prepare a Certificate of Construction-Phase Commissioning Process Completion that shall establish the date of completion of construction-phase commissioning process. Certificate of Construction-Phase Commissioning Process Completion shall be submitted prior to requesting inspection for determining date of Taking Over.

END OF SECTION 019113

B01 - MECHANICAL SERVICES PROJECT PARTICULAR

PART 3 PROJECT PARTICULAR SPECIFICATION

300.000 GENERAL

300.030 COMPLIANCES:

- Comply, with applicable clauses relating to; workmanship, installation, work on site, fixing, access, marking, identification, labelling, accessories, testing and inspection, commissioning, operation and maintenance, training, system demonstration, notifications, spare parts and tools, quality control, safety, delivery, storage, protection, certification, programming, documentation, submittals, installation records, surveys, guarantee and warranty etc. as detailed in this specification.
- Comply with the requirements of the infrastructure. The contractor shall ensure that all mechanical building services interfaces and tie in with the site infrastructure utilities is thoroughly coordinated in all aspects including setting out plans, coordinates, levels, type and finish of valve chambers, meter box, hand hole, etc.

300.035 ACCURACY OF DATA AND CONTRACT DRAWINGS:

- The design drawings are diagrammatic and they do not show all physical arrangements, offsets, bends, or elbows which may be required for installation of various materials, equipment, piping, and ductwork systems in allotted spaces. The Contractor shall examine these and other available drawings to determine space limitations and interferences. The Contractor shall be responsible for developing the design to reach detailed design level including making any changes in location of equipment, pipe and ductwork from that shown on drawings and for all physical details required for installation. Cost for adapting Contractor's work to job site conditions shall not be considered as basis of an extra cost to contract. The Contractor shall get submit the design for Client approval before proceed in shop drawings, material procurement or any other construction activities.
- Information pertaining to new and existing conditions that are described in the specifications or appear on drawings are based on available records. While such data has been collected with reasonable care, there is no expressed or implied guarantee that conditions so indicated are entirely representative of those actually existing or that unlooked for developments may not occur. Such information is merely provided to assist the Contractor in his investigation of conditions.
- The Contractor must carefully examine the drawings, specifications and project site, and verify all measurements, distances, levels, materials, equipment, etc. before starting work.
- Drawings shall not be scaled for determining exact dimensions or location of equipment.
- All works not shown on drawings in complete detail shall be installed in conformance with accepted standard practice and manufacturer’s recommendations.
- All items shall be installed in a manner and in locations avoiding all obstructions, preserving headroom and keeping openings and passageways clear. Changes shall be made to the location of equipment and materials as may be necessary in order to meet this requirement.
- Work indicated on drawings, but not mentioned in Specifications, or vice versa, shall be performed as if specifically mentioned or indicated by both

300.036 SUBMITTALS:

- Detailed Design.

- Detailed Design drawings shall be prepared by the Contractor and submitted for Client Approval.
- Detailed Design drawings shall include the following:
  - 1/100 scale floor plans.
  - 1/50 scale enlarged mechanical rooms.
  - 1/25 scale Composite Sections in corridors and mechanical rooms.
  - Miscellaneous Details on appropriate Scale
  - Riser Diagrams.
  - Schedule of equipment
  - Control Drawings.
- Contractor shall include relevant design calculations with each submission

- Shop drawings:
  - Shop drawings shall be produced as required in the contract documents in addition to the following points
  - Shop drawings shall be new drawings prepared by the Contractor and shall not be reproductions or tracings of the contract drawings
  - Drawings shall be overlaid with shop drawings of other trades and checked for conflicts.
  - Shop drawings shall identify the related contract drawing number or related reference drawing.
  - Shop drawings shall be fully dimensioned, including both plan and elevation dimensions from building reference points.
  - Shop drawings shall show schedules and description of equipment, valves, piping and fittings.
  - Shop drawings shall show complete system layout of equipment, components, plumbing fixtures, piping, indicating service clearances, and pipe sizes, fitting types and sizes and hanger support locations.
  - Planned piping layout, including valve and specialty locations and valve-stem movement.
  - Clearances for installing and maintaining insulation.
  - Clearances for servicing and maintaining equipment, accessories, and specialties, including space for disassembly required for periodic maintenance.
  - Equipment and accessory service connections and support details.
  - Exterior wall and foundation penetrations.
  - Fire-rated wall and floor penetrations.
  - Sizes and location of required concrete pads and bases.
  - Scheduling, sequencing, movement, and positioning of large equipment into building during construction.
  - Floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
  - Reflected ceiling plans to coordinate and integrate installation of air outlets and inlets, light fixtures, communication system components, sprinklers, ceiling access panels and other ceiling-mounted items.
  - Mechanical equipment rooms.
  - Interstitial space.
  - Hangers, inserts, supports, and bracing.
  - Pipe sleeves.
  - Shop drawings shall include but not be limited:
  - Complete HVAC floor plans with a minimum of 1/50 scale.
  - HVAC mechanical rooms to a minimum of 1/25 scale.

- Sections of congested areas to a minimum of 1/25 scale.
- Fabricated equipment to a minimum of 1/25 scale.

- Submit shop drawings for review as required by the contract documents. Additional shop drawings may be requested when it appears that coordination issues are not clearly resolved, when there is a question as to whether contract documents are being complied with or the design intent is not being met.

300.040 STANDARDS AND REGULATIONS:

- Contractor to execute Mechanical Works in compliance with Engineering Design Works as shown in drawings, schedules, specifications etc., according to codes mentioned in basis of design report
- Ensure all equipment and systems are designed and installed in accordance with the relevant standards and that operational compatibility exists between the systems and any other system installed in the same location.
- Provide products in accordance with the Construction Products Regulations (CPR). Products covered by harmonised European product standards (hENs) must have a Declaration of Performance (DoP) certificate for the product and be CE marked. Manufacturers of products not fully covered by a hEN or which do not fall within the scope of a hEN shall provide Declaration of Performance documentation in accordance with one of the methods in the CPR.
- All product and materials shall have European product conformity certification or product approval.
- All products shall comply with relevant European standards.
- All fire suppression systems shall comply with NFPA standards.
- All products must have the recognised 'CE Mark' attached.

    - CE Mark (European Conformity) defined as the official certification mark within the European Economic Area that indicates manufacturers' conformity with European Commission directives for health, safety and environmental protection.

- Comply with the requirements of the Local Authority Having Jurisdiction (AHJ).
- Comply with Health Safety Standards of Local Authority Having Jurisdiction (AHJ) and British and European Standards, for products and systems.
- Contractor shall use the latest versions of relevant codes and standards along with the latest amendments where applicable.

    - Where specified standard is withdrawn before date of the project's contract, Contractor shall use the latest standard replacement.
    - All EN standards published only by CEN national members, are considered equivalent and acceptable.

- Should an instance occur in this Specification or on the Drawings in which material or construction methods called for is less than minimum requirement of the reference standards, immediately inform the Engineer in writing, and supply the materials and perform the work as though called for to minimum code standards.

300.050 WARRANTIES:

- All Mechanical works and systems shall have a warranty of at least 2 year or as per the requirements of the local Authority Having Jurisdiction. From the date of completion of the project,

- The following mechanical products shall be provided with warranties from the manufacturer as per the appropriate British Standard (BS), requirements of the local Authority Having Jurisdiction, or a warranty period of at least 2 year; unless shown otherwise below:
    - Boilers
    - Warranty Period: 10 years.
    - Warranty Period: 5 years for Electric Boilers.
    - Chillers
    - Warranty Period: 5 years.
    - Pumps
    - Air Handling Units
    - Recovery Air Handling Units
    - Warranty Period: 5 years.
    - Fans
    - VRV units
    - Warranty Period: 5 years.
    - Split DX Units
    - Warranty Period: 5 years.
    - Warranty Period: 10 years for Heat Exchangers in packaged plants.
    - Warranty Period: 5 years for self-contained air conditioning units.
    - Fan Coil Units
    - Heat Exchangers
    - LPG systems
    - Natural gas systems
    - Fuel systems
    - Life Safety Equipment and Systems
    - Warranty Period: 5 years

300.055 SPARE PARTS

- Provide spare parts for mechanical equipment and systems as specified in individual mechanical specification sections.
- Provide spare parts for all Life Safety systems as per the relevant NFPA standards and the requirements of the Local Authorities Having Jurisdiction.

300.060 MANUFACTURERS

- For manufacturers: Refer to manufacturer list as applicable.
- Material and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture, supply and servicing of the specified products for at least 5 years. The standard products shall have been in satisfactory commercial or industrial use for 5 years prior to bid opening. The 5 year experience shall be satisfactorily completed by a product that has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures However, digital electronics devices, software and systems such as

controls, instruments, computer work station, shall be the current generation of technology and basic design that has a proven satisfactory service record of at least 5 years.

- Material and equipment shall be supported by a service organization that maintains a complete inventory of repair parts and is reasonably located within the project reach.

300.070 QUALITY ASSURANCE

- Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.
- Installer shall be qualified with at least 5 years of successful installation experience on projects incorporating HVAC systems and equipment similar to that required for the project.
- Asbestos products or equipment or materials containing asbestos shall not be used.
- Equipment and materials to be installed outdoors shall be of the type that is designed, manufactured and listed or approved for outdoor installation by being resistant to the adverse effects of weather prevailing at the project location. The additional protective measures against outdoor weather required by the manufacturers' installation instructions and prevalent practice shall be provided.
- Where two or more equipment or components are of the same class, the same manufacturer shall be used for selecting the equipment; component parts of the entire system need not be products of the same manufacturer.
- Equipment shall be provided with suitable lifting attachments to enable equipment to be lifted in its normal position. Lifting attachments shall withstand any handling conditions that might be encountered, without bending or distortion of shape, such as rapid lowering and braking of load.
- Nameplate bearing manufacturer's name or identifiable trademark shall be securely affixed in a conspicuous place on equipment, or name or trademark cast integrally with equipment, stamped or otherwise permanently marked on each item of equipment.
- Supply mechanical equipment complete with electrical motors.
- All equipment with moving parts shall be protected against personal injury.

300.075 TESTING AND COMMISSIONING

- Comply with requirements of section "Z251 TESTING AND COMMISSIONING OF MECHANICAL SERVICES".

- TEST CERTIFICATES:
    - Where testing specific to the project is required, ensure test certificates include
    - Project title.
    - Details and date of test.
    - Instruments used, serial numbers, calibration dates.
    - Signature of those witnessing test.
    - Contractor's name.
    - Specific location of the item in the Works.

- INSPECTION AND TESTS - ON OR OFF-SITE:
    - Submit schedules showing those parts of the Works for which inspections and tests are required in the specifications, to substantiate conformity with the Specification and for which records are required to be maintained.

- Should any alternative item be proposed which does not carry appropriate certification, ensure independent testing is carried out at no expense to the Employer to confirm compliance.
- Where required, provide formal method statements supported by risk assessments detailing the procedures for carrying-out on-site tests. Agree in advance with all parties procedures for inspections and tests including periods of notice.
- Where a test indicates non-compliance with the Specification submit immediately details of the non-compliance and proposals for corrective action.
- Arrange access for personnel who require to be in attendance, to manufacturer's or other off site premises when any inspections and tests carried out.
- Attendance or otherwise of the supervisory personnel during specified inspections or tests will not reduce the obligations or restrictions of the Contract.
- Carry out all tests required by legislation under the direction of a competent person.

- INSPECTIONS AND TEST RECORDS:
  - Prepare a set of drawings and/or report sheets to record accurately the test and inspection information including the following:
  - Plant identification, section and installation under test.
  - Manufacturer's reference number.
  - Date, time, duration of test, weather conditions.
  - Test results with itemised readings including records of all other checks and tests.
  - Maintain records of all specified inspections and tests performed including third party and works test certificates.
  - Include in records, as appropriate, details of the element, item, batch or lot, the nature, number and date of the inspections and tests, the number and type of deficiencies found, any corrective action taken and other relevant particulars.
  - Maintain all records on-site for inspection. On completion of the Works, include copies in the operating and maintenance manuals.
  - Submit copies of records within one week of request.

- TESTING AND COMMISSIONING OF SERVICES:
  - The contractor is to adhere to a programme for pre-commissioning checks, setting to work, commissioning and performance testing, as set out in the specifactions documents, and allow for all costs incurred.
  - Where required, provide formal method statements supported by risk assessments detailing all commissioning procedures.
  - Provide all necessary facilities to enable tests to be witnessed and inspections carried out either on-site or at manufacturer's works.
  - The CA will only witness test proceedings, confirm recorded results and determine if the specified requirements have been satisfied.
  - If following test or inspection, any plant or part thereof is shown to be defective or not conforming to the specification, the CA will reject such defective parts by written notice, within reasonable time, indicating area of dispute.
  - Appoint an "approved engineer" to supervise the whole of the testing, commissioning, performance testing and instruction of client's staff.
  - Provide all specialised personnel (including manufacturer's representatives) and co-ordinate their activities.

- Test all equipment, material and systems as detailed in sections. If an inspection or test fails, repeat the procedure, until satisfactory results are obtained.
- Complete all tests before any paint, cladding or similar materials are applied or before services are concealed.
- Ensure all requirements such as cleanliness, protection from harmful external and internal elements etc. are provided prior to commencement of commissioning.
- Following satisfactory completion of testing and when the installations are in a safe and satisfactory condition, set to work, regulate and adjust, as necessary, to meet the specified design requirements.
- Provide all necessary instruments and recorders to monitor systems during commissioning and performance testing.
- Provide test equipment subject to a quality assurance procedure complying with BS EN ISO 10012.
- Do not start performance testing, including system demonstration, system proving or environmental and capacity testing, until commissioning of the system is completed to the satisfaction of the CA.
- Maintain on-site full records of all commissioning and performance testing, cross referenced to system components and on completion of the Works include a copy in each Operating and Maintenance Manual.
- Provide all certification documents for approval by the CA before any system is offered for final acceptance.

- Commissioning of building services as required by ADL2 (Section 5.16 - 5.28).
- Commissioning of building services as required by Section 6 of Scottish Technical Handbook, Section 6.7.

- Gas, fuel oil, and water for testing and commissioning will be provided by the contractor.

- COMMISSIONING PROCEDURES:

  - Observe the following requirements when commissioning the Engineering Services.
  - Progressive static testing will be witnessed by the CA when work is presented for testing. This will include:

  - Insulation resistance tests.
  - Earth fault loop impedance tests.
  - Earth continuity tests.
  - Pipeline pressure tests.
  - Air Ductline Pressure Tests.

  - Finalise commissioning, taking into account site progress and availability of related services, with CA and Contractor, and agree access required for controls, etc.
  - Completion for operational purposes implies the bulk of snagging has been offered to the CA and that remedial work has been completed. All fans, pumps etc. tested for operation, polarity, phase sequence and impedance etc.
  - Pre-commissioning examination and testing to ensure that each system or item of equipment is complete, in a safe condition and all notices are displayed.

- OPERATIONAL DEMONSTRATION:

- Provide a written statement to the CA confirming that each installation has been correctly tested and commissioned and that the performance requirements can be achieved.
- Demonstrate to the CA that all system components are operating correctly, and the completely integrated installation will function in accordance with the specified performance requirements.
- Run each plant for
- Provide a log book and record all hours run.
- Carry out performance testing in both summer and winter conditions.
- Provide equipment to simulate loads to allow for the full testing of the air conditioning system(s) for the following areas:

- OPERATING AND MAINTENANCE INSTRUCTIONS:
  - The Contractor shall provide operating and maintenance instruction manuals covering each and every item of equipment and devices furnished or erected by the Contractor prior to "Substantial Completion".
  - Each separate manual shall consist of the following:
  - Neatly typewritten table of contents including contractor's name, address and telephone number; list of each product referenced in manual; and name, address and telephone number of installing contractor and maintenance contractor for each product.
  - Tabbed sections of catalog data and literature for each product including model number, description and component parts; operating procedures; maintenance procedures; servicing and lubrication schedules; description of sequence of operations; parts lists; illustrations, assembly drawings and diagrams required for maintenance; any additional drawings, diagrams, charts or written text which may be required to supplement product data for particular installation; certified test and balance report; list of control point labels, and wiring diagrams.
  - Copy of warranty, bond and/or service contract issued for each product including an information sheet for operations personnel with proper procedures in event of a product failure and instances which might affect validity of warranties or bonds.
  - Full size sheets, if required, shall be folded into special holding pockets. Faxed, handwritten, or illegible materials are not acceptable.
  - Prior to final inspection or acceptance, fully instruct designated facility operating and maintenance personnel on operation, adjustment and maintenance of products, equipment and systems. Review contents of operating and maintenance manual with personnel in full detail to explain all aspects of operations and maintenance.

- SYSTEMS USED BEFORE PRACTICAL COMPLETION:
  - Systems may not, without the prior written approval of the CA be used before Practical Completion. Systems to be used before practical completion for the benefit of the Contractor and/or Subcontractor must have all defective consumable elements (including lamps and tubes) replaced by new not more than seven days prior to Practical Completion.
  - No system shall be put into use prior to handover to the employer, except for testing and commissioning, unless in accordance with the following procedure:
  - Following the receipt of written instructions, the Subcontractor shall operate designated parts of the Subcontract Works, provided that such operation is practicable

and does not prejudice the Subcontractor's responsibilities and obligations under the Subcontract.

- Additionally and with adjustment to the Subcontract sum, the Subcontractor, shall if instructed, provide:
- Comprehensive insurance including indirect loss for any plant being operated
- Maintenance of the installation
- Re-instatement of the installation to as new condition prior to handover to the Employer
- Allow the defects liability period to commence on handover.

300.080 TRAINING OF PERSONNEL

- Training of Owner's personnel shall include:
    - on-site overview of the overall HVAC System.
    - Refer to relevant U and Z sections for specific training on each of the components of the HVAC System.

300.090 DELIVERY STORAGE AND HANDLING

- DELIVERY:
    - Provide an adequate and safe protection for all materials and products during transport to site.
    - Deliver all tubes, conduit, trunking and associated equipment with open ends effectively plugged, capped or sealed.
    - Deliver all ductwork, tubes, conduit, trunking and associated equipment with open ends effectively plugged, capped or sealed.

- HANDLING:
    - Offload and transport about the Works all materials and products as recommended by manufacturers.

- STORAGE:
    - Store all materials and products as recommended by manufacturers.
    - Provide sufficient, safe and secure storage for all materials and products.
    - Provide racks to prevent distortion for storage of conduits, pipes and similar materials.
    - Store all fittings, accessories and sundry items in clean bins or bagged and stowed in racks and maintained under suitable weatherproof cover.

300.100 IDENTIFICATION:

- Where appropriate, ensure that materials, plant and equipment bear the brand name, serial/batch number and any other data required to identify their nature in relation to the Works.
- Comply with requirements of section "Z254 IDENTIFICATION – MECHANICAL".

310.000 DESCRIPTION OF THE WORKS - GENERAL

310.010 GENERAL:

- Liaise with the Statutory Authorities and provide any test notices required to ensure final connections are made in accordance with the requirements of the testing and commissioning programme
- Provide all formalities in connection with Test Notices, Agreement and Application for Supply Forms etc. Ensure all documents requiring the Employer's signature are forwarded to the CA in time to meet the building programme in order for the necessary test and supply arrangements to be made. No additional payments will be made for expenses incurred due to reconnections, re-visits etc., by Supply Authorities or any other officials.
- Contractor to ensure all mechanical equipment are accessible for maintenance, providing raised walk walkways and platforms where necessary.
- Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.
- For large equipment make provisions for the necessary openings in the building to allow for admittance of all equipment before closing in.
- Contractor to ensure all mechanical services crossing fire rate walls and slabs to be provided with appropriate fire stopping material as per manufacturer guidelines, BS codes and standards, Local Authorities regulations.

    - For Fire-Resistance-Rated Penetrations, Horizontal Assembly Penetrations, and Smoke Barrier Penetrations: Comply with requirements to fire-stopping and fill materials specified in Penetration Fire-stopping section in Division P Section.

- Contractor to ensure no chilled water pipes penetrate water vapor seals.
- All systems related to Life Safety shall require the approval of the Local Authorities Having Jurisdiction (AHJ).
- Contractor shall provide access panels in false ceiling under all FCUs, valves, dampers, etc. in coordination with ID consultant.
- Work Coordination:

    - Contractor shall coordinate with ID consultant or Engineer locations of thermostats, ceiling fixtures and access panels such as, but not limited to: air outlets, lighting, signage, etc., and shall provide a coordinated Reflected Ceiling Plan for the ID consultant’s or Engineer’s approval.
    - All Trades shall work in cooperation with each other, and fit their work into the structure as job conditions may demand. In general, priority shall be arranged as follows: (in order of preference)

    - Recessed lighting fixtures
    - Piping which must be drainable
    - Sheet metal ductwork
    - Lighting fixtures
    - Plumbing waste lines, downspouts, vents and sprinkler piping
    - Gravity water lines
    - Heating hot and chilled water lines
    - Refrigerant lines
    - Plumbing water and gas and air lines
    - Electrical conduit
    - Control wiring conduit

- Contractor shall ensure Noise Levels are respected in different areas as detailed in this specification, providing sound attenuation where necessary, irrespective of whether they are shown on drawings or not.

- Protection of roof:
    - The contractor are cautioned that they must exercise extreme care in any activity involving contact with any installed roof membrane.
    - Construct protective plywood (3/4 in. thick) runways across the roof for moving, setting, and installing equipment and piping systems. No activity on the roof will be permitted without this protection. Start runways at the point of origin of any equipment placed on roof and terminate at the point of installation on curb or base. Any and all repairs necessary to bring the roofing system to its original condition shall be made by an approved Roofing Contractor and paid for by the Contractor responsible for the damage.
- Continuity of existing services:
    - Do not interrupt or change existing services without prior written approval. When interruption is required, coordinate length of service time with employer to minimize disruption of occupant activities. Depending on the length of the service time temporary equipment or pipe installation or relocation might be required and shall be provided to maintain continuity of operation of existing facilities.

- Demolition works:
    - Disconnect, demolish, and remove HVAC systems, equipment, and components indicated to be removed.
        - Piping to be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
        - Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.
        - Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
        - Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.
        - Equipment to Be Removed: Disconnect and cap services and remove equipment.
        - Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
        - Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Government.
    - If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.
    - Where existing kitchen extract systems require inspection and cleaning prior to modification, employ a specialist to undertake the following works approved in accordance with Loss Prevention Standard LPS 2084:
        - Inspect and clean ductwork that may be contaminated with combustible deposits.
        - Make recommendations for access improvements to any areas where there is currently limited access making cleaning / maintenance impractical.
        - [.....]
    - Removed materials must not be reused unless otherwise specified or directed to be so.
    - Arrange and pay for disconnecting, removing and capping utility services within areas of demolition. Place markers to indicate location of disconnected services. Identify service lines and capping locations on Project Record Documents.

- Refrigerant shall be recovered from any refrigeration unit that will be removed or salvaged. Recovered refrigerants must be bottled in pressure containers suitable for shipping per DOT requirement and remain property of the Government. Salvage or disposal by Contractor is not permitted.

- Cutting and Patching:
  - Additional openings required in building construction shall be made by drilling or cutting.
  - Fill holes which are cut oversize so that a tight fit is obtained around the objects passing through.
  - Do not pierce beams or columns without written permission from the structural engineer and then only as directed.

310.015 PIPING SYSTEMS – COMMON REQUIREMENTS:

- Install piping according to the following requirements and Sections Z210a,b and c specifying piping systems.
- Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- Firefighting: Comply with BS requirements for installation of fire protection piping materials.
- Firefighting: Install drain piping at low points of piping systems.
- Firefighting: Install pressure gages at top of each standpipe.
- .
- Firefighting: Provide dedicated supports for the firefighting piping. Common supports with other building services shall not be utilized.
- Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- Install piping to permit valve servicing.
- Install piping free of sags and bends.
- Install fittings for changes in direction and branch connections.
- Install piping to allow application of insulation.
- Select system components with pressure rating equal to or greater than system operating pressure.
- Size reduction shall be made using reducing fittings; bushings are not acceptable.
- Independently support piping so that its weight shall not be supported by the equipment to which it is connected.
- Mitered ells, notched tees, and orange peel reducers are not acceptable. On threaded piping, bushings are not acceptable.
- "Weldolets" and "Threadolets" may be used for branch takeoffs up to one-half (1/2) the diameter of the main.
- Cover ends of piping during installation to keep inside of piping clean.
- Piping shall not be routed through electrical rooms or transformer vaults, or above transformers, panelboards, or switchboards, including the required service space for this equipment, unless the piping is serving this equipment.
- Use only wrenches having square flat jaws, or non-metallic strap wrenches on brass specialties; wrench marks not permitted.
- Select system components with pressure rating equal to or greater than system operating pressure.

- Install escutcheons for penetrations of walls, ceilings, and floors in finished spaces.
- Sleeves are not required for core-drilled holes.
- Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
- Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to section Z210a,b and c for materials.
- Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
    - Install steel pipe for sleeves smaller than 6 inches in diameter.
    - Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
    - Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
    - Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.
- Verify final equipment locations for roughing-in.
- Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.
- Conveniently locate control panels, hardware and devices, valves, gauges, cleanout fittings, and other equipment or specialties requiring frequent reading, adjustments, inspection, repairs, or removal and replacement.
- Install thermometers and gauges to be easily read from floors, platforms, and walkways.
- Install piping at the required slope indicated in the specification and/or drawings
- Install piping to allow application of insulation plus 25 mm clearance around insulation.
- Locate groups of pipes parallel to each other, spaced to permit valve servicing.

310.030 EQUIPMENT INSTALLATION – COMMON REQUIREMENTS:

- Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.
- Install equipment to allow right of way for piping installed at required slope.
- Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts

310.040 CONCRETE BASES:

- Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
    - Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
    - Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
    - Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
    - Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
    - Install anchor bolts to elevations required for proper attachment to supported equipment.
    - Install anchor bolts according to anchor-bolt manufacturer's written instructions.
    - Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified for cast-in-place concrete in relevant E sections.

310.050 GROUTING:

- Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.
- Clean surfaces that will come into contact with grout.
- Provide forms as required for placement of grout.
- Avoid air entrapment during placement of grout.
- Place grout, completely filling equipment bases.
- Place grout on concrete bases and provide smooth bearing surface for equipment.
- Place grout around anchors.
- Cure placed grout according to manufacturer’s written instructions.

310.060 WELDING:

- The below compliments specifications on welding in subsequent sections.
- The Contractor is entirely responsible for the quality of the welding and shall:
    - Conduct tests of the welding procedures used by his organization, determine the suitability of the procedures used, determine that the welds made will meet the required tests, and also determine that the welding operators have the ability to make sound welds under standard conditions.
    - Comply with the set standards in the specification.
    - Perform all welding operations required for construction and installation of the piping and systems.
- Examine each welder at job site, in the presence of the Engineer, to determine the ability of the welder to meet the qualifications required. Test welders for piping for all positions, including welds with the axis horizontal (not rolled) and with the axis vertical. Each welder shall be allowed to weld only in the position in which he has qualified and shall be required to identify his welds with his specific code marking signifying his name and number as signed.

- Provide the Engineer with a list of names and corresponding code markings. Retest welders who fail to meet the prescribed welding qualifications. Disqualify welders, who fail the second test, for work on the project.
- Field bevels and shop bevels shall be done by mechanical means or by flame cutting. Where beveling is done by flame cutting, surfaces shall be thoroughly cleaned of scale and oxidation just prior to welding. Conform to specified standards.
- Utilize split welding rings or approved alternate method for joints on all pipes above 50 mm to assure proper alignment, complete weld penetration, and prevention of weld spatter reaching the interior of the pipe.
- Piping shall not be split, bent, flattened, or otherwise damaged either before, during or after installation.
- Replace and re-inspect defective welds. Repairing defective welds by adding weld material over the defect or by peening will not be permitted. Welders responsible for defective welds must be re-qualified.
- Electrodes shall be stored in a dry heated area, and be kept free of moisture and dampness during the fabrication operations. Discard electrodes that have lost part of their coating.

310.080 DESIGN CRITERIA:

- EXTERNAL NOISE CRITERIA:
    - Building services plant noise level to comply with local planning / environmental authority requirements and statutory noise nuisance legislation.

310.090 PERFORMANCE REQUIREMENTS:

- Contractor to execute all mechanical works ensuring efficiency and safety of installation and operation of systems, coordinating between all mechanical and other services.

310.100 CONTROL REQUIREMENTS:

- Refer to BMS and Control Sections W60

320.000 DESCRIPTION OF FIREFIGHTING WORKS

320.010 FIREFIGHTING GENERAL:

- Refer to drawings

320.020 DESIGN PARAMETERS:

- Refer to drawings

330.000 DESCRIPTION OF PLUMBING WORKS

330.010 PLUMBING GENERAL:

- Refer to drawings

330.020 DESIGN PARAMETERS:

- SANITARY APPLIANCES

- Comply with BS EN 806-2, BS EN 806-3 and complementary guidance in BS 8558, CIBSE Guide G: Public Health & Plumbing Engineering, CIBSE TM13: Minimizing the Risk of Legionnaires' Disease, HSE Approved Code of Practice & Guidance L8 (The Control of Legionella Bacteria in Water Systems),
- The requirements of local codes and regulations, and the requirements of EN standards.
- Comply with appropriate WRAS guidance.
- On healthcare projects comply with the requirements of HTM 04-01.

- RAINWATER PIPEWORK / GUTTERS
    - Relevant parts of BS EN 12056
    - BS 8490 for siphonic roof drainage systems.
    - Current Building Regulations Technical Guidance Documents and requirements of the Local Authority, local codes, local regulations, and the requirements of EN standards.
    - Design rainfall intensity 240mm / Hr
    -

- FOUL DRAINAGE ABOVE GROUND
    - Relevant parts of BS EN 12056
    - Current Building Regulations Technical Guidance Documents and requirements of the Local Authority, local codes, local regulations, and the requirements of EN standards.

- DRAINAGE BELOW GROUND
    - Relevant parts of BS EN 12056 for gravity drainage systems in the building.
    - BS EN 752 for drain systems outside the building.
    - Current Building Regulations Technical Guidance Documents and requirements of the Local Authority, local codes, local regulations, and the requirements of EN standards.

- COLD WATER
    - BS EN 806-2, BS EN 806-3 and supplementary guidance in BS 8558, CIBSE Guide G: Public Health & Plumbing Engineering, CIBSE TM13: Minimizing the Risk of Legionnaires' Disease, HSE Approved Code of Practice L8 and associated guidance HSG274 Part 2 (The control of legionella bacteria in hot and cold water systems).
    - For water supply systems outside buildings comply with the requirements of BS EN 805.
    - The requirements of local codes and regulations, and the requirements of EN standards.
    - Comply with appropriate WRAS guidance.
    - On healthcare projects comply with the requirements of HTM 04-01.

- HOT WATER:
    - BS EN 806-2, BS EN 806-3 and complementary guidance in BS 8558, CIBSE Guide G: Public Health & Plumbing Engineering, CIBSE TM13: Minimizing the Risk of Legionnaires' Disease, HSE Approved Code of Practice L8 and associated guidance HSG274 Part 2: The control of legionella bacteria in hot and cold water systems.
    - The requirements of local codes and regulations, and the requirements of EN standards.
    - Comply with appropriate WRAS guidance.
    - On healthcare projects comply with the requirements of HTM 04-01 and associated supplements.

- Unvented hot water storage systems to be complete with "unvented kits" and pressure regulating valve to comply with the Building Regulations safety requirements. Indirectly heated storage water heaters to comply with BS EN 12897.

340.000 DESCRIPTION OF HEATING VENTILATION AND AIR CONDITIONING WORKS

340.010 HVAC GENERAL:

- Refer to drawings

340.020 DESIGN PARAMETERS:

- CENTRAL REFRIGERATION PLANT
  - The requirements of local codes and regulations, and the requirements of EN standards.
  - Ambient temperatures
  - Worse condition between applicable European standard, and Local Authorities code
  - Supply air cooled chiller capable of providing rated output at an ambient dry bulb temperature as mentioned in basis of design report

- EXTERNAL ENVIRONMENTAL DESIGN CONDITIONS:
- As mentioned in basis of design report

- INTERNAL ENVIRONMENTAL DESIGN/COMFORT CONDITIONS:
  - operative temperature and humidity levels for all room types/areas shall be as per basis of design report

- INTERNAL NOISE CRITERIA:
  - Limiting noise levels for all types of areas shall be as per basis of design report

- EQUIPMENT SOUND POWER LEVEL
  - Ensure noise precations are in accordance witht the European Council and Parliament Directive 2003/10/EC.
  - Air handling units maximum outlet/discharge sound power levels (dB re 10^{-12} W):
  - 63 Hz (94 dB)
  - 125 Hz (90 dB)
  - 250 Hz (89 dB)
  - 500 Hz (89 dB)
  - 1 kHz (89 dB)
  - 2 kHz (84 dB)
  - 4 kHz (82 dB)
  - 8 kHz (79 dB)
  - Fans maximum power levels (dB re 10^{-12} W) at design air flow
  - 63 Hz (55 dB)
  - 125 Hz (50 dB)
  - 250 Hz (48 dB)
  - 500 Hz (47 dB)
  - 1 kHz (48 dB)

- 2 kHz (46 dB)
- 4 kHz (42 dB)
- 8 kHz (37 dB)

- Fan coil units limiting sound power levels of at design cooling output, dB re 10^{-12} Pa at frequency (Hz) below:

- 63 Hz: 70 dB
- 125 Hz: 65 dB
- 250 Hz: 60 dB
- 500 Hz: 55 dB
- 1 kHz: 53 dB
- 2 kHz: 50 dB
- 4 kHz: 48 dB
- 8 kHz: 45 dB
- Sound power level measurements

- Determine the sound power levels of fan coil units in accordance with:

    - BS EN 16583

        - Acoustic test facilities / measurement in accordance with BS EN ISO 3741 or BS EN ISO 3744 or BS EN ISO 3745 or relevant parts of BS EN ISO 3743, or relevant parts of BS EN ISO 9614.

- The below condensing units sound power levels will vary based on their capacities and efficiencies, as such their noise impact shall be checked & verified per- project basis to meet the target levels in line with applicable code requirements for internal and environmental noise criteria:

- Roof mounted air conditioning unit

- Chiller sound power level

- 125 Hz: 98 dB
- 250 Hz: 96 dB
- 500 Hz: 95 dB
- 1 kHz: 93 dB
- 2 kHz: 94 dB
- 4 kHz: 88 dB
- 8 kHz: 81 dB
- Limiting overall chiller sound pressure level in free field conditions (dBA) 67 at distance from machine (m) 10

- Note: the above sound power levels of each equipment shall be verified and checked versus proposed equipment selection at each frequency level. In case the sound power levels greatly differ from the above then the selection shall be verified by an acoustic study to ensure it has low noise impact on outdoor environment, building façade and internal occupied spaces and that the target noise levels achieved due to equipment sound are within allowable code requirements for internal and environmental noise criteria, as applicable.

340.030 PERFORMANCE OBJECTIVES:

- CENTRAL REFRIGERATION PLANT

    - Coordination for Chiller, Fluid Coolers

- Coordinate size and location of concrete bases with actual equipment provided. Cast anchor-bolt inserts into base.
- Coordinate sizes, locations and anchoring attachments of structure steel support structures.
- Coordinate sizes and location of roof curbs, equipment supports and roof penetrations with actual equipment provide

350.000 MECHANICAL SPECIFICATIONS CONTENT GUIDELINE

350.010 SPECIFIC MECHANICAL WORKS SECTIONS:

- N10a – PORTABLE FIRE EXTINGUISHERS
  - PORTABLE FIRE EXTINGUISHERS
- N13a – SANITARY APPLIANCES
  - W.C. PANS
  - SINKS
  - DOMESTIC SINKS
  - WASH BASINS
  - SHOWER UNITS
  - CISTERNS
  - WASTE FITTINGS
  - TRAPS
  - TAPS
- R10a – RAINWATER PIPEWORK AND GUTTERS
  - ROOF OUTLETS
  - BALCONY OUTLETS
- R11 – FOUL DRAINAGE ABOVE GROUND
  - FLOOR GULLIES
  - FLOOR DRAINS
  - CLEANOUTS
  - TRENCH DRAINS
  - TRAPS
  - COVER PLATES
  - AIR ADMITTANCE VALVES
  - VENT CAPS
- R12b – DRAINAGE BELOW GROUND
  - PIPELINES
    - PLASTIC PIPES - GRAVITY
    - METAL BANDED FLEXIBLE COUPLINGS ADAPTORS AND BUSHES
    - PLASTIC PIPES - PRESSURE
  - FITTINGS, TERMINALS, ACCESSORIES
    - CONNECTORS
    - GREASE INTERCEPTOR
    - LINT INTERCEPTOR
    - AIR RELEASE VALVES TO PRESSURE PIPES
    - WASH-OUT VALVES TO PRESSURE PIPES

        - ANCHORS TO PRESSURE PIPES
        - FLEXIBLE COUPLINGS
        - PRIVATE PACKAGED SEWAGE SUMP PUMP
    - INSPECTION CHAMBERS/ACCESS/TANKS/SOAKAWAYS
        - CONCRETE INSPECTION CHAMBERS
        - PETROL/OIL INTERCEPTOR UNIT
        - CAST IRON ACCESS COVERS AND SEATING TO BS EN 124
- S10B COLD WATER
    - WATER METERS (NEW BUILD)
    - ORIFICE DISCS
    - PRESSURISATION EXPANSION UNITS
- S11 HOT WATER
    - STORAGE WATER HEATER(S)
    - ORIFICE DISCS
    - THERMOSTATIC MIXING VALVES
    - THERMAL CIRCULATION VALVES
- S20 – TREATED WATER
    - MAINS WATER ANALYSIS
    - WATER TREATMENT METHODS
    - REVERSE OSMOSIS PLANT
    - FILTRATION EQUIPMENT
    - ULTRAVIOLET DISINFECTION
    - BASE EXCHANGE WATER SOFTENER
- S33 – LIQUEFIED PETROLEUM GAS
    - STORAGE VESSELS
    - PUMP AND MOTOR
    - GAS VAPORISERS
    - GAS PRESSURE REGULATORS AND AUTOMATIC CHANGE-OVER DEVICES
    - GAS DISTRIBUTION PIPING
    - GAS METERS
    - GAS DETECTION AND ALARM EQUIPMENT
    - GAS SAMPLING SYSTEM
- S41 – FUEL OIL STORAGE AND DISTRIBUTION
    - ABOVE GROUND STEEL OIL STORAGE TANKS
    - BELOW GROUND STEEL OIL STORAGE TANKS
    - SERVICE TANKS
    - OIL STORAGE TANKS, THERMOPLASTIC (ABOVE GROUND)
    - FUEL OIL DISTRIBUTION PIPING
    - LEAK DETECTION SYSTEM
    - FILTERS
    - STRAINERS
    - CATHODIC PROTECTION OF BURIED METALLIC TANKS
    - FUEL PUMPS
- S60 – FIRE HOSE REELS

- LANDING VALVES CABINETS
- FIRE HOSE REELS CABINETS

- S62 – WET RISERS
  - STANDPIPE SYSTEM
  - LANDING VALVES
  - BREECHING INLET
  - WET PIPE ALARM CHECK VALVE
- S63 – SPRINKLERS
  - SPRINKLER SYSTEMS FOR DOMESTIC AND RESIDENTIAL OCCUPANCIES
  - EMERGENCY INLET UTILISING INLET BREECHING
  - SPRINKLER INSTALLATION CONTROL VALVES
  - WET PIPE ALARM CHECK VALVE
  - SPRINKLER HEADS
- S70 – GAS FIREFIGHTING
  - INERT GAS SYSTEM
  - CHEMICAL GAS SYSTEM
  - DETECTORS AND ACTIVATORS
  - PRESSURE RELIEF VENTS
  - PIPING, FITTINGS AND INSULATION
  - DISCHARGE NOZZLES
  - GAS CYLINDERS
  - CYLINDER VALVES AND ACTUATORS
  - POST DISCHARGE VENTING OF PROTECTED ENCLOSURES
  - ODOURISER
  - GAS FIRE FIGHTING SYSTEM CONTROL AND ALARM PANEL
- S71 – FOAM FIREFIGHTING
  - FOAM
  - FOAM INLET BOX
  - FOAM EQUIPMENT
  - FOAM SYSTEM AND CONTROL PANEL
- T14 – HEAT PUMPS
  - EQUIPMENT
  - REFRIGERANTS
  - REFRIGERANT PIPING SYSTEMS
  - AIR-TO-WATER HEAT PUMPS
- T60 – CENTRIFUGAL REFRIGERATION PLANT
  - REFRIGERANTS
  - REFRIGERANT LEAK DETECTION
  - REFRIGERANT PIPING SYSTEM
  - PACKAGED AIR COOLED LIQUID CHILLER - SCREW COMPRESSOR
- U12 – KITCHEN VENTILATION
  - KITCHEN CANOPIES AND HOOD FIRE SUPPRESSION
  - GREASE FILTERS
  - KITCHEN VENTILATION GAS SAFETY INTERLOCK FACILITIES

- KITCHEN ECOLOGY UNIT

- U41 – FAN COIL AIR CONDITIONING
- U60 – AIR CONDITIONING UNITS
  - ROOF MOUNTED AIR CONDITIONING UNIT
  - COMPUTER ROOM AIR CONDITIONING UNITS
  - REMOTE AIR COOLED CONDENSING UNIT
  - REFRIGERANT PIPING SYSTEM
  - REFRIGERANT PIPEWORK INSULATION
- W60 – CENTRAL CONTROL BUILDING MANAGEMENT

350.020 GENERAL MECHANICAL WORKS SECTIONS – Z PARTS:

- Z210a – PIPELINES AND PIPEWORK – HVAC
  - STEEL PIPES AND FITTINGS
  - PLASTICS PIPES AND FITTINGS
  - PIPEWORK ACCESSORIES
    - ESCUTCHEONS

- Z210b – PIPELINES AND PIPEWORK – PLUMBING
  - PLASTICS PIPES AND FITTINGS
  - PIPEWORK ACCESSORIES
    - ESCUTCHEONS

- Z211a – PIPELINE ANCILLARIES – HVAC
  - INDICATING STOP VALVES
  - TEST AND DRAIN VALVE
  - BALL DRIP VALVE
  - TUNDISHES
  - GAUGES
  - LOOSE ITEMS
  - CHECK VALVES
  - PRESSURE REDUCING VALVES
  - WATER MOTOR-OPERATED ALARMS
  - WATER FLOW DETECTORS
  - PRESSURE SWITCHES
  - VALVE SUPERVISORY SWITCHES
- Z211b – PIPELINE ANCILLARIES – PLUMBING
  - STOP VALVES
  - REGULATING VALVES
  - DOUBLE REGULATING VALVES
  - FLOW MEASUREMENT VALVES
  - FLOW REGULATORS AND COMBINATION VALVES
  - TEST PLUGS
  - PIPELINE STRAINERS
  - TUNDISHES

- FLOAT OPERATED VALVES
- GAUGES
- CONTROL VALVES
- WATER HAMMER ARRESTORS
- LOOSE ITEMS
- CHECK VALVES
- VERIFIABLE BACKFLOW PREVENTER WITH REDUCED PRESSURE ZONE (RPZ VALVE)
- PRESSURE REDUCING AND CONTROL VALVES
- DIRECT ACTING SAFETY VALVES
- DRAIN COCKS
- VENT COCKS
- AUTOMATIC AIR VENTS
- EXPANSION ARRANGEMENTS/DEVICES AND FLEXIBLE CONNECTIONS

- Z220a - PUPMS – HYDRONIC
  - PUMP AND MOTOR
- Z220b – PUMPS – PLUMBING
  - PUMP AND MOTOR
  - PACKAGED WATER BOOSTER SETS
- Z220c – PUMPS – FIREFIGHTING
  - PUMP AND MOTOR - ELECTRIC FIRE PUMP
  - PUMP AND MOTOR - DIESEL FIRE PUMP
  - PUMP AND MOTOR - JOCKEY FIRE PUMP
  - PUMP MOTOR STARTERS- ELECTRIC FIRE PUMP
  - PUMP STARTER MOTOR - DIESEL
  - PUMP STARTER MOTOR – JOCKEY
- Z221 – WATER TANKS CISTERNS
  - GLASS REINFORCED PLASTICS SECTIONAL TANK
  - MOULDED PLASTIC CISTERNS
  - GLASS REINFORCED PLASTIC CISTERNS
- Z223 – STORAGE CYLINDERS AND CALORIFIERS
  - CALORIFIER AND STORAGE VESSELS
- Z225 - CLEANING AND CHEMICAL TREATMENT
- Z230 – AIR DUCTLINES AND ANCILLARIES
  - DUCTWORK AND FITTINGS
  - SHEET METAL DUCTWORK TO DW/144
  - SHEET METAL DUCTWORK FOR KITCHENS TO DW/172
  - FIRE RESISTING / SMOKE EXTRACT DUCTWORK
  - INSULATED DUCTWORK
  - ACCESSORIES
  - REGULATING DAMPERS
  - FIRE DAMPERS
  - SMOKE DAMPERS
  - COMBINATION SMOKE AND FIRE DAMPERS
  - VAV TERMINAL UNITS

- Z240 - AIR HANDLING UNITS
- Z241 – FANS
- Z242 – AIR FILTRATION
- Z243 – COILS, HEAT RECOVERY EQUIPMENT AND GAS ELECTRIC BATTERIES
    - HOT WATER HEATING COIL
    - CHILLED WATER COOLING COIL
    - REFRIGERANT COOLING COIL
    - HEATER BATTERIES - ELECTRIC
    - RUN-AROUND COILS
    - PLATE HEAT EXCHANGER
- Z245 – SILENCERS ACOUSTIC TREATMENT
    - SILENCERS
    - ACOUSTIC FLEXIBLE CONNECTORS
    - ACOUSTIC LOUVRES
- Z246 – GRILLES DIFFUSERS LOUVRES
- Z250a – THERMAL INSULATION – HAVC
    - MINERAL WOOL THERMAL INSULATION - PIPEWORK
    - CLOSED CELL MATERIALS THERMAL INSULATION - PIPEWORK
    - CALCIUM SILICATE THERMAL INSULATION
    - MINERAL WOOL THERMAL INSULATION - DUCTWORK
    - CLOSED CELL MATERIALS THERMAL INSULATION - DUCTWORK
    - THERMAL INSULATION – PLANT
- Z250b – THERMAL INSULATION - PLUMBING
    - MINERAL WOOL THERMAL INSULATION - PIPEWORK
    - CLOSED CELL MATERIALS THERMAL INSULATION - PIPEWORK
    - THERMAL INSULATION – PLANT
- Z251 – TESTING AND COMMISSIONING OF MECHANICAL SERVICES
- Z252 – VIBRATION ISOLATION MOUNTINGS
    - MAT AND PAD MOUNTINGS
    - MOUNTINGS
    - EQUIPMENT HANGINGS
    - PIPEWORK HANGERS
    - HORIZONTALLY RESTRAINED SPRING MOUNTINGS
    - INERTIA BASES
    - PIPEWORK NOISE VIBRATION ISOLATION
    - PIPE, WALL AND RISER SEALS
- Z254 – IDENTIFICATION - MECHANICAL
- Z290 – FIXING TO BUILDING FABRIC
- Z291 – OFF-SITE PAINTING AND ANTI-CORROSION TREATMENT

350.030 MECHANICAL PIPEWORK, PIPE INSULATION, AND PIPE ANCILLARIES GUIDELINE:

- Guideline table:

		Piping Material	Piping Insulation	Piping Ancillaries (Valves)	Pipe Hangers & Supports
HVAC	Hydronic Piping	Z210A	Z250A	Z211A	Z210A
	DX AC Units	U60	U60	U60	U60
	LPG	S33	-	S33	S33
	Fuel	S41	-	S41	S41
PLUM BING	Domestic Water	Z210B	Z250B	Z211B	Z210A
	Sanitary drainage (above/below ground)	Z210B	-	-	Z210A
	Rain Water	Z210B	-	-	Z210A

D GROUNDWORK

D20 EXCAVATING AND FILLING

To be read with Preliminaries/General conditions

The outlined specifications provided herein are indicative and for guidance purposes only. The Contractor shall develop his own Technical Specifications upon Contract Award based on design requirements and geotechnical conditions at the project site.

GENERALLY/THE SITE

111 SITE FEATURES

- Before starting work ascertain and verify with the Engineer which existing fences, gates, walls, roads, paved areas and other site features if any are to be retained and protected. Materials arising from demolition and clearance of site features are to be removed from Site.

120 TREES AND SITE VEGETATION

- Before starting work ascertain and verify with the Engineer which trees, shrubs and areas of turf and site vegetation if any are to be retained and protected.

CLEARANCE/EXCAVATING

140 REMOVAL OF TREES

- Cut down trees and tree stumps, grub up main roots, fill in voids with approved material and dispose of all wood.
- Protected area: Do not cut roots within precautionary protection area.
- Excavation in protected area:
  - Backfill as soon as possible or temporarily line with polyethylene sheet to reduce evaporation.
- Outside protected area: Give notice of roots exceeding 25 mm and do not cut without approval.
- Cutting:
  - Make clean smooth cuts with no ragged edges.
  - Pare cut surfaces smooth with a sharp knife.

141 REMOVAL OF SITE VEGETATION

- Clear Site of hedges, bushes, scrub and undergrowth, grub up and dispose of large roots. Do not use herbicide without prior approval.

151 PROTECTION OF FEATURES AND VEGETATION

- Site features, trees, shrubs and areas of site vegetation indicated or directed to be retained are to be protected from damage, preserved and maintained by the Contractor in a manner approved by the Engineer.

168 SITE CLEARANCE

- Timing: Before topsoil stripping, if any.
- General: Clear Site of general debris and rubbish. Dispose of by removing from Site as directed. Do not compact topsoil.

169 TURF

- Not required to be retained and protected may, at the Contractor's discretion, cost and/or profit be:
  - lifted, removed and sold, or
  - left to be incorporated with existing topsoil.

220 STRIPPING TOPSOIL

- General: Before beginning general excavation or filling, strip topsoil from areas where there will be regrading, buildings, pavings/ roads and other areas shown on drawings.
- Depth:
  - Remove to an average depth of: as **directed by the Engineer**.
  - Give notice where the depth of topsoil is difficult to determine.
- Handling: Handle topsoil for reuse or sale in accordance with Clause 182.
- Around trees: Do not remove topsoil from below the spread of trees to be retained.

221 TREATING TOPSOIL

- Treatment: Apply a suitable translocated non-residual and approved herbicide.
- Timing: Not less than two weeks before excavating topsoil.

225 HANDLING TOPSOIL

- Standard: To BS 3882.
- Aggressive weeds:
  - Species: Included in the Weeds Act, section 2 or the appropriate Wildlife and Countryside Act for the relevant jurisdiction.
  - Give notice: Obtain instructions before moving topsoil.
- Contamination: Do not mix topsoil with:
  - Subsoil, stone, hardcore, rubbish or material from demolition work.
  - Other soil or material containing aggressive weeds, sharps, plastics and non-soil forming materials and notifiable animal or plant diseases.
  - Oil, fuel, cement or other substances harmful to plant growth.
  - Other classifications of topsoil.
- Multiple handling: Keep to a minimum. Use topsoil immediately after stripping.

226 WATERWAYS

- Temporarily divert as necessary ditches, field drains and other waterways encountered during excavations and reinstate on completion. If reinstatement is not possible obtain instructions.

227 EXISTING WATERCOURSES

- Which have been diverted and are to be filled must be cleared of all vegetable growth and soft deposits before filling.

228 EXISTING PUBLIC UTILITIES

- Ascertain and verify the positions and routes of existing underground public utilities, if any, on or adjacent to the Site. Mark, protect, maintain, temporarily or permanently re-route; seal, abandon or remove to the approval of and in cooperation with relevant utilities authorities.

229 EXCAVATIONS FOR STRUCTURES GENERALLY

- Materials and conditions:
  - If obtained, the Employer shall have made available to the Contractor, such data on hydrological and sub-surface conditions as may have been obtained by or on behalf of the Employer from investigations undertaken relevant to the Works, but the Employer takes no responsibility as to the correctness, accuracy or validity of any such data. The Contractor shall be responsible for his own assessment and interpretation thereof and shall in any event be deemed to have carried out his own investigation, inspection and examination of the Site and its surroundings and to have satisfied himself before submitting his Tender, as to:

    the form and nature thereof, including the sub-surface and hydrological conditions,

    means of access, the extent and nature of work and the material and conditions likely to be encountered, including the occurrence of rock or unstable ground and,

    In general, to have obtained all necessary information in connection therewith and made due allowance in his Tender as to risks, contingencies and all other circumstances which may influence or affect the undertaking of excavation and earthwork.

- Methods:
  - Submit details of proposed methods of working which may cause nuisance, damage or danger to people and/or property.
  - Submit details of expansive chemicals used for breaking rock.
  - Submit detailed narrative describing means, methods and techniques to be implemented in excavation works.

- Material arising from excavations:
  - The excavated material should be the property of the Contractor to transport and dispose properly, unless otherwise indicated on drawings or specified. Subject to approval of the Engineer, if found suitable, it can be used as selected fill and backfill on site.

- Approved fill and backfill material:
  - Approved fill and backfill material arising from excavations is to be carefully handled and stockpiled in a manner that will exclude foreign or undesirable material. Stockpiles are to be neatly and compactly constructed in an approved manner adjacent to excavations or elsewhere on Site as directed.

- Topsoil for preservation:

- Before beginning general excavation or filling, excavate topsoil from required areas and keep separate from excavated subsoil.

- Benching:
  - Surfaces of ground with a gradient greater than 1 in 5 which are to receive fill, are to have horizontal benches cut to match the depths of compacted layers of filling.

- Adjacent excavations:
  - Where an excavation encroaches below a line drawn at an angle from the horizontal of 45 degrees for dry stable soil or 30 degrees for wet clays or soils below water table from the nearest formation level of another higher excavation then all work within the lower excavation and backfilling thereto must be completed before the higher excavation is made, unless detailed support structure proposals have been submitted and approved by the Engineer.

- Excavated formations generally:
  - Obtain instructions if:

    Natural bearing formation of undisturbed subsoil is not obtained at depth shown on the Drawings.

    Formation contains soft or hard spots or highly variable material.

- Excavated formations in made up ground:
  - Excavate down to a natural bearing formation of undisturbed subsoil unless otherwise instructed. Obtain instructions if this is obtained at a lesser depth than shown on the Drawings or is not obtained at the depth shown on the Drawings.

- Excavated formations:
  - Excavated formations are to be inspected and approved by the Engineer before new work is laid on them. Give 24 hours written notice of when excavations will be ready for inspection. If, after inspection, surfaces become unsuitable due to water, frost or other causes excavate further and backfill with approved material. Proceed with subsequent operations and overlay formations as soon as possible after approval.

- Preparation:
  - Remove carefully by hand if instructed, the bottom 200 mm depth of trench and pit excavations immediately prior to laying concrete, bedding material, pipework and the like.
  - Trim bottoms of excavations to required profiles, levels and grades and remove all loose material.
  - Compact bottoms of excavations to approval.

- Anti-termite treatment:
  - Destroy ant-nests and vermin encountered during excavations. Apply to surfaces of structural excavations, an approved proprietary and EPA certified pesticide solution of "Dieldrin" or "Aldrin" in clean water, with a spray maintaining a pressure of 150 psi, at the rate recommended by the manufacturer and approved by the Engineer.

- Sides of excavations:
  - Responsibility and risk for upholding sides of excavations and protecting them against erosion rests solely with the Contractor.

- Earthwork support:

- Use as necessary to support sides of excavations and remove on completion unless otherwise instructed. In the event of any collapse occurring while excavations are open bear the cost of and re-excavate and reinstate such excavations and other work affected, to approval.

- Steel sheet piling:
  - Use as necessary to support sides of excavations and remove on completion unless otherwise instructed.

- Special support:
  - The standards listed below, or equivalent International standards, shall apply the excavation of special geotechnical works:

    BS EN 1537 Execution of special geotechnical work - Ground anchors,
    BS EN 14199 Execution of special geotechnical work - Micropiles,
    BS EN 14490 Execution of special geotechnical work - Soil nailing.

  - Use as necessary to uphold excavations against sides of adjoining buildings, public footpaths, roads and the like and remove on completion unless otherwise instructed. Contractor is responsible for preventing any damage to, and protecting: buildings, utilities and structures to remain on site or adjacent to site.

  - Design by a qualified professional Engineer with minimum 10 years' experience in the management, design, installation and monitroing of support systems of equal complexity. Construct special support system to uphold and support sides of excavation to protect adjacent structures roads and the like comprising all or part of the following works, installation and testing of micropiles, bracing, anchors, shotcrete, nails top-down concrete wall and dewatering.

  - Submit shop drawings showing layout, number, length and location of anchors, bracing, micropiles, calculations showing the adequacy and stability of the proposed system.

  - Excavation support and protection system design and calculations shall be acceptable to authorities having jurisdiction, and should include:

Calculations for excavation support and protection, including but not limited to the following:

Soil parameters used and their substantiation.

Codes, standards and methods followed.

Principle underlying selection of system.

- Provide a detailed narrative describing means, methods and techniques to be implemented for construction of excavation support and protection systems. The Method Statement shall include, but not limited to, the following:

  Details of equipment and monitoring instrumentation, quality control, testing and reporting procedures, work program, and any other information required by the Engineer.

  Contingency plan outlining procedures to be adopted in the event that problems arise during construction work.

- Monitor vibrations during installation and monitor support deformations of sides of excavations until permanent construction is able to withstand lateral soil and hydrostatic pressure.

- Submit photographs or video files prior to commencement of the works, showing the existing condition of adjacent structures and adjoining site works that may be construed as damage caused by excavation and earthwork operations.

- Micropiles:

  - Install micropiles before starting excavation. Extend micropiles below excavation grade level to depths adequate to prevent lateral movement. Accurately align micropiles to vary not more than 20 mm from a horizontal line and not more than 1:120 out of vertical alignment.

- Anchors and nails:

  - Prior to drilling, investigate to ensure that installation of anchors will not interfere with or cause damage to underground utilities or structures adjacent to the site. Submit design, calculations, detailed narrative of construction methodology, shop drawings, layout, number, length and dimensions of anchors.

  - Drill to required length for each anchor or nail. Maintain accurate work records and produce a log for each drill hole in a form acceptable to the Engineer, including the following data:

    Project name and number,
    Location and identity of drill hole,
    Diameter of drill hole,
    Date and time of starting and completing drilling,
    Overall length of drill hole,
    Description of soil materials recovered,
    Description and location of obstructions encountered,
    Ground-water conditions,
    Remarks, including conditions encountered.

- Drill, install, grout, and tension anchors. Test load-carrying capacity of each anchor and replace and retest deficient tiebacks at no extra cost.

  Test loading shall be observed by a qualified professional engineer responsible for design of excavation support and protection system.

  Maintain anchors and nails in place until permanent construction is able to withstand lateral soil and hydrostatic pressures.

- Bracing:

  - Submit design, calculations, detailed narrative of construction methodology, shop drawings showing layout, number, length and dimensions of struts.

  - Install internal bracing, to withstand lateral earth and hydrostatic pressures during excavation work, including any surcharges.

  - Locate bracing to maximize clear space and allow other permanent work. If necessary to move brace, install new bracing before removing original brace.

  - Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

    Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.

    Coordinate the removal of bracing with the Contractor of the other package executing the basement permanent construction.

- Unstable ground:

  - Inform the Engineer without delay if any newly excavated face will not remain unsupported sufficiently long to allow necessary earthwork support to be inserted. If instability is likely to affect adjacent structures or roadways take appropriate emergency action. Responsibility for preventing instability rests solely with the Contractor.

  - Carry out geological mapping of rock joints exposed by excavation works, define unstable wedges, and provide stabilization measures with design calculations.

- Obstructions:

  - Where old foundations, beds, drains and similar obstructions are encountered obtain instructions before proceeding. Break out and remove obstructions and seal off drain ends. Remove contaminated earth and disinfect soil surfaces as instructed.

- Excessive Excavation:

  - Bear the cost of and unless otherwise instructed backfill and compact to approval any excavations taken:

    wider than required, with selected fill material;

    deeper than required, with “Blinding” concrete, unless otherwise instructed.

- Unauthorised excavations:

  - Bear the cost of and backfill and compact as instructed to approval.

230 PROBE DRILLING

- Generally: Carry out probe drilling in order to determine the presence or otherwise of cavities below excavated formations under foundations and/or footings, as directed by the Engineer. The number and location of the drill holes shall be as shown on Drawings or otherwise as instructed and approved by the Engineer. At least one drill hole shall be drilled below each footing. The depth of drill holes shall be at least double the longest plan dimension of the respective footing, and deeper if so directed by the Engineer.

- Method of drilling: The minimum drill-hole diameter shall be 76 mm. Circulation may be either water or air. Percussion drilling will be allowed provided that the rate of penetration at a fixed number of RPM and the thrust on the drill bit is recorded continuously throughout the drill hole. Should any variation in the RPM or thrust be necessary, such variation shall be recorded.

- Drilling records: The Contractor shall maintain and produce a record of each drill hole, which shall indicate the depths, if any, at which tool drops, loss of circulation and changes in the rate of penetration occurred and/or changes in the nature of the rock. A copy of each drilling record shall be submitted immediately after completion of each respective drill hole. Following completion of all drill holes, the Contractor shall submit a bound report which shall include all original drilling records together with a site plan identifying and locating all drill holes.

- Grout filling to cavities and fissures: Based upon the drilling results, the Engineer shall instruct the Contractor as to whether or not grouting at a location is required. The level at which the grouting shall take place will usually be foundation level, or as given by the Engineer. The Contractor shall undertake pressure grouting of cavities and fissures in accordance with the Engineer's instructions. The pressures to be used shall be sufficient to ensure that the cavities are filled. Grouting shall continue until grout appears in other drill hole(s), or until the Engineer decides that sufficient grout take has been achieved. The grout mix shall be proportioned as 1 part cement to 3 parts sand, with a water content adequate to give a workable mix. The proportions may be changed to suit the actual conditions with the agreement of the Engineer.

- Concrete filling to cavities and fissures: If cavities and fissures are accessible from the excavated level, the filling shall be carried out either by pouring and compacting cyclopean concrete or by pouring lean concrete, as directed by the Engineer, until the void(s) is completely filled. Allowance should be made for shrinkage as necessary.

- Backfilling of drillholes and site clearance:

  - Unless otherwise directed by the Engineer, drill holes that are not grouted shall be backfilled with grout in accordance with the Engineer's instructions. All mud and debris shall be removed from the foundation area, and the site left clean.

300 EXCAVATION FOR PIPE TRENCHES

- Commencement:
  - Do not begin excavation for any section of work until a full supply of pipes and fittings required for that section is available on Site.

- Adjacent excavations:
  - Underground pipelines must be set out so that their excavations do not encroach below a line drawn at an angle from the horizontal from the nearest lower edge of any adjacent building foundations. The angle is to be 45 degrees for dry stable soil or 30 degrees for wet clays or soils below water table. If this condition cannot be met obtain instructions before proceeding.

- Headings:
  - Drive accurately to required line and gradient and provide adequate support. Construct in approved lengths to size required to contain permanent work. Obtain approval before commencement of pipe laying or other work.

- Trench width:
  - For pipes smaller or equal to 500mm, OD +500
  - For pipes between 600 and 900 mm, OD+1000
  - For pipes larger or equal to 1000 mm, OD+1200

- Excessive trench width:
  - Bear the cost of increased pipe strength or additional pipe protection where required by the Engineer due to excavations being taken wider than specified.
  - Bear the cost of and unless otherwise instructed backfill to approval any excavations taken deeper than required, with Blinding concrete.

- Excessive trench depth:
  - Bear the cost of and unless otherwise instructed backfill to approval any excavations taken deeper than required, with Blinding concrete.

- Battered sides:
  - Excavation with battered sides will not be permitted in public highways, private gardens or within 30 m of any building or other structure.

- Excavation in fill:
  - Embankments and other areas of fill are to be filled and compacted as specified to a height of at least 600 mm above top of pipe before trench is excavated.

- Excavation in existing pavements:
  - Is to be executed carefully and to minimum widths. Use methods which will give trenches a straight and vertical face and maintain pavement at original level.

- Combined trenches:
  - Where one pipe is at a lower level than an adjacent pipe in a common trench:
    a sub-trench is permissible provided soil of step is stable.
    if a sub-trench is not permissible, the whole trench is to have a depth related to the lower pipe, with increased thickness of bedding to upper pipe as necessary.
    lower pipe is to be backfilled with thoroughly compacted approved granular material up to a level not less than half-way up the higher pipe.

- Formation for pipe beds generally:
  - Remove carefully by hand, the bottom 200 mm depth of trenches immediately prior to laying bedding material or pipes
  - Remove unstable material, rock projections, boulders and hard spots and replace with approved filling material, well consolidated
  - Harden local soft spots by tamping in bedding material.

- Formation in rock:
  - Excavate to 150 mm below bed level and replace with approved granular material or blinding concrete, as directed.

- Subsoil for backfilling:
  - Carefully handle and stockpile approved excavated subsoil material required for backfilling, in temporary spoil heaps adjacent to excavations or elsewhere on Site as directed.

DISPOSAL OF MATERIALS

410 EXCAVATED TOPSOIL STORAGE

- Stockpile excavated topsoil required to carry out subsequent topsoiling operations in temporary spoil heaps on Site as instructed.

415 EXCAVATED TOPSOIL REMOVAL

- General: Remove surplus topsoil from Site.

420 TOPSOIL STORAGE HEAPS

- Standard: To BS 3882.
- Protection:
  - Do not place any other material on top of storage heaps.
  - Do not allow construction plant to pass over storage heaps.
  - Prevent compaction and contamination.

441 SURPLUS SUBSOIL

- Excavated material: Remove from Site excavated materials which are surplus to requirements or deemed by the Engineer as unsuitable for filling, backfilling, spreading and levelling or stockpiling.
- Retained material: Spread and level surplus subsoil on site.
  - Protected areas: Do not raise soil level within root spread of trees that are to be retained.
- Remaining material: Remove from site.

442 TIPS

- Use only authorised tips for disposal of all materials removed from Site. Pay all tipping fees and charges arising in connection therewith.

443 PERMISSIBLE DEVIATIONS FROM FORMATION LEVELS

- Beneath mass concrete foundations: ±25 mm.
- Beneath ground bearing slabs and R.C. foundations: ±15 mm.
- Embankments and cuttings: ±50 mm.

- Ground abutting external walls: ±50 mm, but such as to ensure that finished level is not less than 150 mm below DPC.

450 WATER

- Generally: Keep all excavations free from water until:
  - Formations are covered.
  - Below ground constructions are completed.
  - Basement structures and retaining walls are able to resist leakage, water pressure and flotation.
- Drainage: Form surfaces of excavations and fill to provide adequate falls.
- Removal of water: Keep surface excavations well drained. Provide temporary drains, sumps and pumping as necessary. Do not pollute watercourses with silt laden water.
- Keep excavations free from water and keep water from excavations clear of other work.

454 GROUND WATER LEVEL, SPRING OR RUNNING WATER

- Give notice: If it is considered that the excavations are below the water table.
- Springs/ Running water: Give notice immediately if encountered.

456 DRAINAGE DITCHES AND SUMPS

- Obtain approval for location of any drainage ditches and sumps; backfill and compact to approval when no longer required.

457 PUMPING AND DEWATERING

- General: Do not disturb excavated faces or stability of adjacent ground or structures adjacent to or around excavations by pumping and dewatering operations.
- Pumped water: Discharge without flooding the site or adjoining property.
- Drainage ditches and sumps: Construct clear of excavations. Backfill and compact to approval when no longer required.
  - Locations: Obtain approval for location of any drainage ditches and sumps;
- Unless otherwise instructed, maintain and continue pumping and dewatering operations until such time that the dead-weight of permanent works is at least 1.1 times the up lift applied from any ground water encountered in excavations, including expected fluctuations in water table level during the construction period.
- Do not stop dewatering before informing the Engineer and obtaining his approval.

460 PERMANENT DRAINAGE SYSTEM

- Permanent drainage system is not to be used for disposal of water from excavations without approval.

FILLING

470 EARTH FILLING GENERALLY

- To be approved material arising from excavations or approved imported filling material, free from clay, debris, harmful matter, organic materials and other materials liable to decompose or chemically react, and capable of being compacted as specified.

471 SATISFACTORY SOILS

- Soil Classification **[Groups GW, GP, GM, SW, SP, and SM according to BS 5930] [Groups A-1, A-2-4, A-2-5, and A-3 according to AASHTO M 145]**, or a combination of these groups; free of rock or gravel larger than [(75 mm)] in any dimension, debris, waste, vegetation, and other deleterious matter.
  - Liquid Limit: 35% Maximum
  - Plasticity Index: 12 Maximum.

472 UNSATISFACTORY SOILS

- Soil Classification **[Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to BS5930] [Groups A-2-6, A-2-7, A-4, A-5, A-6, and A-7 according to AASHTO M 145]**, or a combination of these groups.

- Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

- Unsatisfactory Soils for Airfield and Roadway Construction: AASHTO M145 soil classification groups A-6, and A-7, or a combination of these group symbols; and any other material not complying with specified requirements for Satisfactory Roadway/Airfield Soils.

473 EARTH FILLING UNDER BUILDING SLABS AND GENERAL FILL/BACKFILL

- Satisfactory soil. To pass a 75 mm ASTM standard sieve and material passing 5mm BS standard sieve is to have a maximum plasticity index of 12% and a maximum liquid limit of 25%.. No piece is to have its largest dimension greater than one third the thickness of a compacted layer. Gradation of material is to be approved by the Engineer.
- The material shall be non-aggressive with water soluble Chlorides less than 0.05% and water soluble Sulphates (SO3) content less than 0.1% and pH between 6.5 and 8 when tested according to BS EN 1744-1 or BS 1377-3 standard.

474 EARTH FILLING AND EMBANKMENTS

- Under roads and paved areas: Satisfactory soil. Natural material is to conform to the general requirements of **[BS EN 13242] or [AASHTO M 145 soil classification groups A-1, A-2-4, A-2-5, and A-3 when confined, or a combination of these group symbols]**; material shall be free of debris, waste, vegetation, and other deleterious matter, and conforming with the below requirements.
  - Maximum Size: 75mm Max. and not more than third of placement layer thickness.
  - Organic Matter: Not more than 5 percent; BS 1377-3.
  - Maximum Dry Density: Not less than 1.7; BS 1377-4.
  - 4-day soaked CBR: Not less than 8 percent; BS 1377-4 when compacted at 95% max. dry density in accordance with BS 1377.
  - Plasticity Index PI < 20%.

475 IMPROVED SUBGRADE LAYER (IF REQUIRED)

- Subgrade layer: Satisfactory roadway/embankment soil materials, but conforming to the following additional requirements:
  - Size: 100 percent passing a 75 mm sieve and not more than 18 percent passing a 0.075 mm sieve.
  - 4-day soaked CBR: Not less than 15 percent; BS 1377-1 when compacted at 100% BS 1377.
  - Maximum Plasticity Index: 12 percent.
  - The top 150 mm subgrade material should not contain more than 0.1% water soluble Sulphate (SO_3) content and 0.05% total water soluble Chloride content and pH between 6.5 and 8, when tested according to BS EN 1744-1 or BS 1377-3 standards.
  - **[Subgrade material should respect filter criteria specified under Clause 445 below, when the subgrade layer is laid directly underneath and/or above the drainage blanket]**.

476 PERMEABLE DRAINAGE LAYER

- To abutment and retaining walls is to consist of clean no fines material having a maximum size of 20 mm and minimum size of 2 mm, unless otherwise approved by the Engineer, the gradation should be such that D60/D10 is less than 3. Minimum thickness of the drainage layer shall be 300 mm. Filter criteria shall be satisfied at the interface of the drainage layer and the backfill, alternatively a geotextile fabric may be placed as a separator.

477 BEDDING COURSE

- Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; BS EN 13285; except with 100 percent passing a (25-mm) sieve and not more than 8 percent passing a No. 200 (0.075-mm) sieve.

478 FILTER MATERIAL FOR SUBSURFACE DRAINAGE

- Graded mixture of natural or crushed gravel stone with 100% passing a 25mm sieve and 0 to 5% passing a No.4 (4.75mm) sieve.

479 DRAINAGE BLANKET MATERIAL

- Course of washed granular material placed to cut off upward capillary flow of pore water under paved areas.
- Filter material for subsurface drainage: graded mixture of natural or crushed gravel stone with 100% passing a 25 mm sieve and 0 to 5% passing a No.4 (4.75mm) sieve.
- Drainage Blanket Material: Aggregate Material for use in drainage blanket shall be Rapid Draining crushed stone, or crushed or uncrushed gravel conforming to the following properties:

PROPERTY	**RANGE**
Permeability in m/day	300 - 1500

Effective Porosity	0.25
% Fractured Faces (COE Method)	Min. 75%
Cv (D60/D10)	> 3.5
L.A. Abrasion	< 40
California Bearing Ratio (CBR)	> 30%

- The gradation of the Rapid Draining Material for use in Drainage Blanket shall be as follows:

Sieve Designation (mm)	**Percent Passing**
53.0	100
37.5	74 – 100
26.5	55 - 98
13.2	40 - 67
4.75	24 - 36
2.00	15 - 20
0.425	4 - 9
0.075	0 - 4

- The Subgrade layer directly underneath the drainage blanket and the one directly above it shall satisfy the following filter criteria:
  - The 15 % size of Filter (D15 Filter) should not be greater than 4 times the 85 % size of the surrounding material (D85 Surrounding material):
  - D15 Filter < 4 D85 Surrounding material.
  - The 15 % size of Filter (D15 Filter) should not be less than 4 times the 15 % size of the surrounding material (D15 Surrounding material):
  - D15 Filter > 4 D15 Surrounding material.
  - The 50 % size of Filter (D50 Filter) should not exceed 25 times the 50 % size of the surrounding material (D50 Surrounding material):
  - D50 Filter < 25 D50 Surrounding material.
  - The plasticity index of the portion of all filter materials passing sieve # 40 (0.425mm sieve) should not exceed 6%.
  - The filter materials should not contain more than 5% material passing through sieve # 200 (0.075mm sieve).

- Wherever and as shown on the drawings, place drainage blanket under the raft as follows:
  - Compact drainage blanket to required cross sections and thickness to not less than 95 percent of maximum dry density according to BS1377.
  - Place Drainage Blanket in layers, 150mm each.
    When compacted thickness of drainage blanket exceeds 300 mm, place materials in equal layers, with no layer more than 150 mm thick or less than 75 mm thick when compacted.

480 SELECTED FILL

- Selected fill: approved material arising from excavations or approved imported filling material conforming to Clause 473 or 474 hereof as applicable.

481 BACKFILL

- Backfill: Approved material arising from excavations conforming to Clause 473 hereof.

482 PIPE BEDDING MATERIAL AND BACKFILLING FOR PIPE TRENCHES

- Granular Bedding and Backfill materials: Granular bedding shall be composed of natural gravel, crushed gravel or crushed rock, free from dirt, clay, roots, organics and other deleterious materials. Granular bedding according to pipe type, shall conform to the following:

Standard Sieve size (mm)	% By Weight Passing for DI/steel pipes	Standard Sieve size (mm)	% By Weight Passing for UPVC / PE pipes
19.0 (3/4 in)	70-100	4.76 (No. 4)	100
12.7 (1/2 in)	30-75	1.16 (No. 16)	25-75
8.0 (5/16 in)	8-40	0.300 (No. 50)	10-30
4.76 (No.4)	0-10	0.177 (No. 80)	0-10

- For GRP pipes bedding shall be of graded crushed stone 2.83-8.0 mm or as recommended by Manufacturer and approved by the Engineer.

- Sand bedding and initial backfill up to 300 mm minimum above crown of the pipe shall be non-plastic, natural well graded sand having hard, strong, durable angular particles. It shall be clean and free from extraneous materials, clay balls, organic matter or other detrimental material. The amount of fines passing sieve No. 200 shall not exceed 15%.

- Backfill over a pipe shall consist of two different materials: Initial or selected backfill and main backfill. Initial backfill or backfill in contact with the pipes and up to 300 mm minimum above crown of the pipe shall be selected material. Selected fill material shall be similar in composition and gradation to the granular pipe bedding as defined above or the sand bedding described above. The main backfill (for the remainder of the trench) shall be done with suitable material either from material removed in the course of excavating the trench, or imported from approved borrow pit. In either case the backfill material shall conform to backfill described in this section above and will be selected to avoid large stones greater than 76mm.

483 TOPSOIL

- To BS 3882, medium texture, neutral to slightly alkaline reaction, free of stones, pests, weed seeds, roofs, sticks, subsoil and foreign matter.

484 DRAINAGE STONE

- water-borne or crushed, hard durable stone, washed free of loam, sand, clay and other foreign substances and evenly graded from 20 mm minimum to 50 mm maximum size.

485 STONE MULCH

- Water-borne, hard durable gravel, washed free of loam, sand, clay and other foreign substances and evenly graded from 5 mm minimum to 25 mm maximum size and of approved natural colour.

486 CYCLOPEAN CONCRETE

- Cyclopean concrete consists of mass concrete in which large stones larger than 150 mm are deposited as the concrete is placed.

- Concrete for use as backfilling for structural excavation shall be cyclopean concrete. Plums used in cyclopean concrete shall consist of non-reactive broken stone spalls or boulders ranging in size from 200mm to 300mm. They shall be free from sharp or angular edges and shall not form more than 30% of the total volume of concrete. They shall be evenly graded and shall be soaked in water prior to incorporation in the mix. Plums shall be evenly distributed in the concrete mix with a minimum cover of 100mm.

487 ENGINEERED FILL FOR EARTH FILLING UNDER BUILDING SLABS AND FOUNDATIONS

- Engineered fill shall be uniformly graded granular material, capable of being compacted to the specified compaction level, and having adequate permeability to permit free drainage through it. Backfill material shall also conform to the following:
  - Minimum D10 value: 1 mm
  - Maximum Plasticity Index: 10 per cent

- Engineered fill shall satisfy the chemical properties of general fill/backfill material.

488 IMPERVIOUS BACKFILL MATERIALS

- Impervious Backfill materials for structures: Selected cohesive material with 15% to 100% of soil passing a No. 200 (0.075 mm) sieve and 100% passing a 37.5 mm sieve. The cohesive material shall have a maximum Liquid Limit of 35% and a maximum Plasticity Index of 20%.

- The impervious backfill material shall satisfy the chemical properties of general fill/backfill material.

- Place impervious backfill around buildings above structural foundations that are beyond the slab on grade limits.

500 PROPOSED FILL MATERIALS

- Details: Submit full details of proposed fill materials to demonstrate compliance with specification, including:
  - Type and source of imported fill.
  - Proposals for processing and reuse of material excavated on site.
  - Test reports by an approved independent testing agency as required elsewhere.

510 HAZARDOUS, AGGRESSIVE OR UNSTABLE MATERIALS

- General: Do not use fill materials which would, either in themselves or in combination with other materials or ground water, give rise to a health hazard, damage to building structures or instability in the filling, including material that is:
  - Organic.
  - Contaminated or noxious.
  - Susceptible to spontaneous combustion.
  - Likely to erode or decay and cause voids.
  - With excessive moisture content, slurry, mud or from marshes or bogs.
  - Clay of liquid limit exceeding 80 and/or plasticity index exceeding 55.
  - Classified as Unsatisfactory soil.

511 SAMPLES AND TESTS

- Submit 50 kg representative samples of filling materials to an approved laboratory for tests as follows and submit results for approval:
  - For soils with less than 50% fines: sieve analysis and compaction and chemical composition (% sulphates, % chlorides and pH).
  - For soils with more than 50% fines: sieve analysis, Atterberg Limits, Compaction and California Bearing Ratio (CBR) and chemical composition (% sulphates, % chlorides and pH).
  -
  - For all soils: test in accordance with BS 1377-4 to determine the optimum amount of water to be used with fill material to obtain maximum dry density. Test procedure is to be selected on the basis of the gradation of the material.
- Samples and tests are to be conducted for every source of filling material and for each type of filling material encountered.

512 APPROVAL

- Sources and types of filling materials and moisture contents at which they may be placed and compacted are to be those approved after receipt of laboratory test results.

530 PLACING FILL

- Surfaces of excavations and areas to be filled: Free from loose soil, topsoil, organic material, rubbish and standing water.
- Uniformly using approved methods to required dimensions, levels, lines and profiles and to permit water to drain freely.

- Against columns, foundation walls, abutments, culverts and the like only with approval and after concrete and any masonry have been in place for at least 21 days.
- Adjacent structures, membranes and buried services:
  - Do not overload, destabilise or damage.
  - Submit proposals for temporary support necessary to ensure stability during filling.
  - Allow 14 days (minimum) before backfilling against in situ concrete structures.
- Layers: Place so that only one type of material occurs in each layer.
- Earthmoving equipment: Vary route to avoid rutting.

535 COMPACTION GENERALLY

- General: Compact fill not specified to be left loose as soon as possible after placing.
- After compaction: Surface of each layer must be well closed, showing no movement under compaction plant, and without cracks, holes, ridges, loose material and the like.
- Defective areas: Remove and recompact to full thickness of layer using new material.

536 FIELD DENSITY TESTS

- Minimum field density required on compacted earth layers when tested in accordance with BS 1377-9, unless otherwise specified on drawings, is to be:
  - For top 30 cm subgrade layer under slabs within buildings areas
    Or under road, parking and paved area 100% of maximum dry density
  - for ground surfaces prepared to receive fill: 95% of maximum dry density
  - for top 600mm depth of filling under slabs within building areas: 100% of maximum dry density
  - for top 600mm depth of filling under roads, parking and paved areas: 98% of maximum dry density
  - for filling in excess of top 600 mm under same areas last described: 95% of maximum dry density
  - for filling elsewhere, such as landscaped areas: 90% of maximum dry density

- DRAINAGE BLANKET: Wherever and as shown on the drawings, place drainage blanket under the aggregate Base Course, as follows:
  - Compact drainage blanket to required cross sections and thickness to not less than 100 percent of maximum dry density according to ASTM D 1557.
  - Place Drainage Blanket in layers, 150mm compacted thickness each.
  - When compacted thickness of drainage blanket exceeds 300 mm, place materials in equal layers, with no layer more than 150 mm thick or less than 75 mm thick when compacted.

537 PERMEABLE MEMBRANE FOR PLANTERS

- Non-woven, 70% polypropylene, 0.3 mm thick, weighing 70 g/m^2, with permeability to water of 80 l/sec/m^2 at 100 mm head of water.
- Membrane is to be resistant to all naturally occurring soil acidities and to tearing and stress and is to remain unaffected by direct sunlight for up to one month.

540 BENCHING IN FILL

- Adjacent areas: If, during filling the difference in level between adjacent areas of filling exceeds 600 mm, cut into edge of higher filling to form benches 600 mm minimum width and height equivalent to depth of a layer of compacted filling.
- New filling: Spread and compact to ensure maximum continuity with previous filling.
- Surfaces of ground with a gradient greater than 1 in 5 which are to receive fill, are to have horizontal benches cut to match the depths of compacted layers of filling.

550 GEOTEXTILE SHEET

- Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with BS EN 13252 and the following, measured per test methods referenced:
  - Survivability: **[Insert Limit].**
  - Grab Tensile Strength: **[Insert Limit].**
  - Sewn Seam Strength: **[Insert Limit].**
  - Tear Strength: **[Insert Limit].**
  - Puncture Strength: **[Insert Limit].**
  - Apparent Opening Size**[Insert Limit].**
  - Permittivity: **[Insert Limit].**
  - UV Stability: **[Insert Limit].**

- Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with BS EN 13251 and the following, measured per test methods referenced:
  - Survivability: **[Insert Limit].**
  - Grab Tensile Strength: **[Insert Limit].**
  - Sewn Seam Strength**: [Insert Limit].**
  - Tear Strength: **[Insert Limit].**
  - Puncture Strength: **[Insert Limit].**
  - Apparent Opening Size: **[Insert Limit]**.
  - Permittivity: **[Insert Limit].**
  - UV Stability: **[Insert Limit].**

- Geotextile: Place and install in accordance with manufacturer's written instructions and as follows, to the approval of the Engineer.
  - Overlaps shall not, in any case, be less than 25 mm.
  - Place bedding layer as soon as possible after placement of the geotextile, in accordance with approved methods, to thickness shown on Drawings.
  - Remove and replace any geotextile damaged or punctured either before, during or after laying.

553 GROUND SURFACES TO RECEIVE FILLING

- Ground surfaces to receive filling are to be cleared and all vegetation and topsoil removed before filling is placed. Surfaces of ground are to be scarified, pulverised, watered and recompacted to at least 90% of maximum dry density as determined by BS 1377. Compaction is to be to a depth of at least 200 mm

below ground surface. Hard or smooth surfaces are to be roughened before filling is placed. Existing road surfaces and the like are to be broken up and removed or used as part of fill.

554 PLACE FILLING

- Surfaces of excavations and areas to be filled: Free from loose soil, topsoil, organic material, rubbish and standing water.
- Uniformly using approved methods to required dimensions, levels, lines and profiles and to permit water to drain freely.
- Against columns, foundation walls, abutments, culverts and the like only with approval and after concrete and any masonry have been in place for at least 21 days.
- Adjacent structures, membranes and buried services:
  - Do not overload, destabilise or damage.
  - Submit proposals for temporary support necessary to ensure stability during filling.
  - Allow 14 days (minimum) before backfilling against in situ concrete structures.
- Layers: Place so that only one type of material occurs in each layer.
- Earthmoving equipment: Vary route to avoid rutting.

556 DEPOSIT FILLING

- In a manner not to endanger wholly or partly finished structures or sub-structures either by direct pressure or indirectly by overloading banks contiguous to the operation or in any other manner.

557 MOISTURE CONTENT

- Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

  - Do not place backfill or fill soil material on surfaces that are muddy or contain excess water.
  - Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.
  - Jetting or fills or other hydraulic methods involving or likely to involve liquid or semi-liquid pressure will not be permitted.

558 EARTH FILLING UNDER BUILDING SLABS

- Earth filling outside the limits of the slab on grade is to be spread and compacted in layers not exceeding 150 mm compacted thickness, to the limits specified in Clause 536.

559 EARTH FILLING UNDER ROADS AND PAVED AREAS

- The top 600 mm depth of fill is to be compacted to at least 95% of maximum dry density all as determined by BS 1377.
- The top 200 mm subgrade layer is to be compacted to 100% of maximum dry density all as determined by BS 1377.

561 EARTH EMBANKMENTS

- Unless otherwise specified or determined and approved by the Engineer from trial tests in the field, embankments are to formed in horizontal layers not exceeding 200 mm compacted thickness.
- The top 600 mm depth of fill is to be compacted to at least 95% of maximum dry density all as determined by BS 1377.
- Where landscaping, planting, seeding or turfing are required or where instructed the embankment is to be stopped below indicated levels and prepared to receive topsoil, specified elsewhere.

562 MINOR UPFILLING

- Minor Upfilling and local adjustment of levels is to be selected fill spread and levelled in layers not exceeding 150 mm compacted thickness well consolidated and compacted to approval by suitable mechanical means.

563 SUBGRADE LAYER FOR AIRFIELD AND ROADWAY CONSTRUCTION

- Subgrade in Cut:
  - Where the subgrade is located in rock, the subgrade, unless shown otherwise on the Drawings, shall be undercut to a depth of 300 mm by drilling or as directed. No rock shall project more than 50 mm above the undercut surface elevation. The 300 mm thick subgrade layer shall then be constructed in 2 lifts having 150 mm compacted thickness each and using approved subgrade material.
  - Where the subgrade is on in-situ soil which is of a quality and CBR value at least equal to those specified for subgrade, the 300 mm depth of such material immediately below top of subgrade shall be scarified and all roots, sod, vegetable and other undesirable matter and stones larger than 75 mm in any dimension shall be removed. The material shall then be brought to uniform moisture content within the specified range and compacted to 100% AASHTO T180 (Method D) maximum density. The compaction shall be done in 2 lifts having 150 mm compacted thickness each.
  - Where the subgrade (under the shoulders, roadways and vehicular pavements) is on in-situ soil which is unsatisfactory and unsuitable for retention as the subgrade layer, such material immediately below the top of subgrade layer shall be sub-excavated to a depth of 300 mm, hauled away and disposed of unless approved for use for other applications. The subgrade layer shall then be constructed in 2 lifts having 150 mm compacted thickness each, and using approved subgrade material, brought to uniform moisture content within the specified range and compacted to 100% AASHTO T180 (Method D) maximum density. If the material below subgrade does not satisfy the requirement of top 600 mm embankment, it shall be excavated for further 300 mm and replaced by suitable material to satisfy the requirements of subgrade.
  - The underlying natural material shall be scarified, leveled and rolled. The surface of the natural soil shall be approved by the Engineer before placement of suitable material.

- Subgrade in Embankment: The 300 mm minimum depth of embankment immediately below top of subgrade shall consist of selected, approved subgrade material. The material shall be spread in two layers (150 mm thick each) over the full width of the top of embankment, brought to a uniform moisture content within the specified range and compacted to 100% AASHTO T180 (Method D) maximum density.

- Surface Tolerances:
  - All finished elevations, lines and grades shall be in accordance with the details shown on the Drawings. Each cross section shall be checked at maximum intervals of 25m, at each change in cross slope and elsewhere as directed.

– The tolerances on elevations of finished subgrade, top of embankment under the subgrade layer and subexcavated (undercut) surface shall be as follows:

1.

Surface	Tolerances
Finished Subgrade:	
Soil	+10 or -15 mm
Top of Embankment or Sub-excavated Surface:	
Soil	+10 or -15 mm

– When the finished subgrade surface is tested with a 3.7m long straightedge placed parallel to, or at right angles to the centerline, the maximum depression of the surface from the testing by straight edge shall be 12 mm.

- Maintenance of Finished Subgrade: The finished and approved subgrade shall be continuously maintained in a smooth, well compacted and properly drained condition until the sub-base (or base) course is constructed. Reapproval of the subgrade will be required if the overlying course is not constructed within 14 days of subgrade completion or if the subgrade layer is damaged by traffic or any other causes prior to the placement of the sub-base layer.

564 FREQUENCY OF TESTING FOR EMBANKMENT AND SUBGRADE LAYER FOR AIRFIELD AND ROADWAY CONSTRUCTION

- Minimum soil tests required during the construction of subgrade and/or embankment are:

  – One sample for CBR, and laboratory (Moisture - density) or relative density compaction from each source prior to use. Each sample shall represent not more than 5,000 m3.

  – One sample for classification (AASHTO M145) representing not more than 3,000 m3 of the material in use.

  – For every completed layer/lift, one field density shall be determined every 500 m2. Testing shall be in accordance with ASTM D1556 (Sand Cone Method) or ASTM D2167 (Rubber Balloon Method) or ASTM D6938 (Nuclear Method)

610 COMPACTED FILLING FOR LANDSCAPE AREAS

- Fill: Material capable of compaction by light earthmoving plant.
- Filling: Layers not more than 200 mm thick. Lightly compact each layer to produce a stable soil structure.

615 LOOSE TIP FILLING FOR LANDSCAPE AREAS

- Filling: Do not firm, consolidate or compact when laying. Tip and grade to approximate levels in one operation with minimum of trafficking by plant.

616 PROTECTION OF FORMATION

- Do not allow construction traffic on completed filling until the level has been raised not less than 150 mm above formation level by properly compacted temporary protective filling.
- Lift and remove temporary protective filling from Site before beginning permanent construction
- Do not stockpile materials on newly filled areas without permission.

619 BACKFILLING

- Place and compact backfill in excavations promptly, but not before completing the following:
  - All permanent construction below finish grade, including where applicable, basement slabs, damproofing, waterproofing and perimeter insulation and protection
  - Inspecting and testing
  - surveying and measuring for record documents
  - removal of concrete formwork
  - removal of trash and debris
  - removal of temporary shoring, bracing and sheeting.

620 SAND CEMENT MIX

- place sand cement mix in layers of 250mm thickness, each layer well compacted with suitable equipment to 95% of maximum dry density, all as determined by BS 1377-Part 4. The minimum percentage of cement shall be equal to 5%.

621 FILLING TO PLANTING BOXES

- Place not less than 100 mm of drainage stone in bottom of planting box, install permeable membrane fabric and fill with topsoil in lightly compacted layers to a level 100 mm below top of planting box allowing for natural settlement. Place stone mulch to a level 40 mm below top of planting box.

622 BACKFILLING TO PIPE TRENCHES

- Compaction equipment: compact backfilling using approved compaction equipment suited to the particular application and location. Do not use heavy steel or pneumatic rollers for compacting backfill to pipe trenches.
- Initial backfill: where pipe surround does not extend up to a level 300 mm above top of pipe, backfill to that level with initial backfill laid and hand compacted in 150 mm layers.
- Main backfill: unless otherwise specified is to be approved material arising from trench excavations, laid and well compacted in layers not exceeding 200 mm thick. Do not use heavy compactors until there is a minimum of 600 mm cover over pipes.
- Concrete: when backfilling to pipes with concrete beds and surrounds:
  - Do not start backfilling within 24 hours of placing concrete.
  - Do not use heavy compactors.
  - Prevent traffic loads within 72 hours of placing concrete.
- Temporary Bridges are to be provided over trenches to prevent construction traffic damaging pipes after backfilling.

623 RESTORATION OF SURFACES

- Generally: Restoration of asphalt, concrete and gravel pavements and the like is to be with materials and to thicknesses to match the existing pavement. Materials and workmanship are to be in accordance with local authority requirements and as directed by and to the approval of the Engineer.
- Restoration of pavement: Make good to existing and ensure new pavement is to same level and profile as existing to provide a uniform surface.
- Restoration of grassed areas: after backfilling, spread approved topsoil over affected area and seed, fertilize and water until grass is restored to its former condition.
- Restoration of unsurfaced areas:
  - After backfilling, grade surface and any adjoining areas disturbed to provide a level, smooth surface.
  - Proceed with restoration of surfaces as soon as practicable after completion of backfilling operations and in sections if necessary. In every case commence restoration no later than 10 days after backfilling and ensure completion of the restoration within 20 days thereafter.

624 HARDCORE FILLING

- Fill: Granular material, free from excessive dust, well graded, all pieces less than 75 mm in any direction.
  - Test requirements:
    Minimum 10% fines value tested in a soaked condition to BS 812-111.
    Impact value SZ tested to BS EN 1097-2.

- Material:
  - In any one layer only one of the following:
    - Crushed rock (good quality and hard rock other than argillaceous rock) with not more binding material than is required to help hold the stone together.
    - Gravel with not more clay content than is required to bind the material together, and with no large lumps of clay.
    - Natural gravel.
- Filling: Spread and level in 150 mm maximum layers. Thoroughly compact each layer.
- Water Soluble Sulphate (SO_3) content of materials for filling under concrete slabs or adjacent to substructures must not exceed 0.1% by dry weight of material and water soluble chloride content not exceeding 0.05% by dry weight of material and pH between 6.5 and 8, when tested according to EN 1744-1 or BS 1377-3 standards. Test in an approved laboratory and submit results for approval.

625 HARDCORE

- Granular material, free from harmful matter, well graded, passing a 150 mm diameter ring in every direction and in any one layer only one of the following:
  - broken hard stone
  - broken concrete free steel reinforcement and old plaster
  - gravel

627 VENTING HARDCORE LAYER

- Fill: Clean granular material, well graded, passing a 75 mm BS sieve but retained on a 20 mm BS sieve. In each layer only one of the following:
  - Crushed hard rock.
  - Gravel.

- Filling: Spread and level in 150 mm maximum layers. Thoroughly compact each layer whilst maintaining enough voids to allow efficient venting.

730 BLINDING

- Surfaces to receive sheet overlays or concrete:
  Blind with:
  - Concrete where shown on drawings; or
  - Sand, fine gravel, or other approved fine material applied to fill interstices. Moisten as necessary before final rolling to provide a flat, closed, smooth surface.
- Sand for blinding: To BS EN 12620, grade 0/4 or 0/2 (MP).
- Permissible deviations on surface level: +0 -25 mm.

740 ROCK FILL

- Sound, dense, hard and durable rock free from weathering, cracks, seams or other visual defects; rock laterite; broken stone, brick or concrete; or other comparable inert material capable of being placed and compacted as specified.
- Individual pieces are to be clean, angular and neither elongated nor flat, the longest dimension not exceeding twice the shortest dimension.
- No piece is to have its largest dimension greater than one third the thickness of a compacted layer.
- Submit representative samples stating source of supply and obtain approval before delivery to the Site.
- Samples shall be tested by an approved independent testing agency and results shall be submitted for Engineer's approval.

745 ROCK RIPRAP PROTECTION

- Sound, dense, hard and durable rock free from weathering, cracks, seams or other visual defects. Individual rock pieces are to be clean, angular, broad and flat and in accordance with the following size and gradation requirements:
  - no individual piece is to weigh less than 20 kg or more than 70 kg
  - at least 60% of pieces are to weigh not less than 45 kg.

- Submit representative samples stating source of supply and obtain approval before delivery to the Site.
- Samples shall be tested by an approved independent testing agency and results shall be submitted for Engineer's approval.

746 STONE FOR PITCHING TO WATERCOURSES

- Durable, angular, field or quarry stones of approved quality, sound, dense, hard, free from cracks, seams and other structural defects and having a specific gravity not less than 2.4. Individual stone pieces are to be not less than 150 mm thick in any direction and in accordance with the following size and gradation requirements
  - no individual piece is to weigh less than 2.5 kg or more than 25 kg
  - at least 60% of pieces are to weigh not less 15 kg.

- Submit representative samples stating source of supply and obtain approval before delivery to the Site.
- Samples shall be tested by an approved independent testing agency and results shall be submitted for Engineer's approval.

747 WORKMANSHIP

- Stability: Before laying hardcore take necessary precautions to ensure stability of adjacent structures.
- Filling: Ensure excavations and areas to be filled are kept free from soil and rubbish. Spread and level hardcore in 300 mm maximum layers each well consolidated with a suitable mechanical rammer.
- Beds: Spread and level in 150 mm maximum layers. Thoroughly consolidate each layer with vibratory roller, vibrating plate compactor, vibro tamper or other suitable means.
- Blinding: Surface of hardcore to receive sheet overlays or concrete is to have sufficient blinding material applied to fill surface interstices to provide a close smooth surface.
- Tolerance: On surface level of blinded hardcore is to be +0 mm and -25 mm.

748 PLACING ROCK FILLING

- Rock filling: Is to be formed in horizontal layers not exceeding in thickness the approximate average size of the rocks within the layer, except that no layer shall exceed 600 mm, each layer is to be compacted and approved before the next is laid.
- Placing rock: Place rock in each layer so that all large stones are well distributed and the voids completely filled with smaller stones, earth, sand or gravel to form a solid and homogenous layer.
- Compaction: Unless otherwise specified or determined and approved by the Engineer from trial compaction tests in the field, compact each layer of rock filling by at least twelve passes of:
  - towed vibratory roller with static load of at least 50 kg per 25 mm width of roller
  - grid roller with load of at least 225 kg per 25 mm width of roller
  - other approved plant.

749 PLACING ROCK RIPRAP

- Rock riprap protection:
  - Place and lay rocks to provide minimum number of voids, using approved methods suited to the particular application, location and sizes of rock material.
  - Place larger rocks in footing trenches and on surfaces of slopes.

- Loose riprap:
  - Lay rocks with flat face uppermost, parallel to intended finished surface and roughly arranged in close contact.
  - Fill voids between rocks with rock chips of largest possible size.

- Grouted riprap:
  - Lay rocks with flat face uppermost, parallel to intended finished surface and roughly arranged in close contact.
  - Fill voids between rocks with cement-sand mortar 1:3 to full depth of the rock.
  - Remove excess mortar by brushing.
  - Keep finished work moist for three days after grouting.

751 STONE PITCHING TO WATERCOURSES

- Trimming: Trim sides and bed of watercourse to required profile.

- Place pitching by hand and bed firmly on 75 mm gravel or other approved material to the depth shown on the Drawings. Pitching is to be roughly square on all faces and the upper (water) face roughly dressed. Courses are to be laid to break joint.

D30 PILING

To be read with Preliminaries/General conditions

GENERAL

1.1 Scope

Provide all labor, materials, plant, and supervision for:

- Installation of piles (bored, CFA, driven, or precast as applicable)
- Temporary works (casings, drilling fluids, support systems)
- Reinforcement, concreting, and finishing
- Testing, monitoring, and quality control

1.2 Contractor's Responsibilities

Contractor shall:

- Review and interpret ground investigation data
- Carry out additional investigations if required
- Submit detailed **pile installation plan** for approval
- Be fully responsible for construction method and performance

1.3 Submittals

- Method statement including:
    - Piling method and equipment
    - Sequence of works
    - Quality control procedures
- Daily piling programme submission
- Test reports and as-built records

1.4 Site Conditions

- Contractor shall:
    - Assume full responsibility for interpretation of subsurface conditions
    - Report unexpected ground conditions immediately
    - Verify presence of contaminated materials if encountered

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1.5 Protection of Adjacent Structures

- No damage to structures or services permitted
- Monitor movements with approved instrumentation
- Stop works and implement mitigation if movement occurs

2. SYSTEM PERFORMANCE

2.1 Piling Method

- Submit details of:
  - Pile type
  - Installation method
  - Equipment
  - Any alternative method requires approval

2.2 Performance Requirements

- Contractor shall demonstrate:
  - Load capacity
  - Settlement performance
  - Construction control measures

2.3 Working Loads

- Pile loads and group configuration:
  - As indicated on drawings

2.4 Pile Length and Penetration

- Pile toe level and penetration:
  - As per drawings
- Minimum penetration into bearing strata required

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3. MATERIALS

3.1 Concrete

- Concrete shall comply with:
  - BS EN 206
  - BS EN 1992-1-1
- Requirements:
  - Continuous, monolithic placement
  - High workability for tremie placement
  - No contamination or segregation

3.2 Concrete Production and Testing

- Trial mixes required prior to construction
- Sampling and testing:
  - Regular compliance testing during works
- Reject non-compliant materials

3.3 Reinforcement

- Reinforcement shall:
  - Be clean and free from corrosion
  - Be stored properly and protected
  - Be fixed as per drawings
- Splicing:
  - Mechanical couplers for tension piles
- No tack welding permitted

3.4 Drilling Fluids and Casings

- Temporary casing:
  - Required to maintain bore stability
- Bentonite slurry:
  - To approved standards and properties

4. EXECUTION

4.1 Site Preparation

- Remove unsuitable surface materials prior to piling
- Prepare working platform to required level

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4.2 Bored Piles

- Boreholes shall be:
    - Stable throughout excavation
    - Free from collapse or contamination
- Use casing or drilling fluid where required

4.3 Concreting

General

- Continuous concreting without interruption
- Prevent contamination by soil or water

Tremie Concreting

- Required for underwater concreting
- Maintain:
    - Minimum embedment of tremie in concrete (≥ 2 m)
    - Continuous flow to avoid segregation

4.4 Casing Extraction

- Extract casing while concrete remains workable
- Maintain sufficient concrete head to prevent:
    - Necking
    - Contamination

4.5 Reinforcement Installation

- Install centrally with proper cover
- Ensure stability during concreting

4.6 Temporary Works

- Provide temporary support where required
- Prevent pile damage during construction

5. TOLERANCES

- Position tolerance:
    - As specified in drawings

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- Verticality:
    - Within allowable deviation
- Raking piles:
    - Maintain specified inclination
- No forcible correction of concrete piles allowed

6. QUALITY CONTROL

6.1 General

- Implement full QA/QC procedures
- Maintain records of:
    - Bore logs
    - Concrete volumes
    - Reinforcement details

6.2 Concrete Testing

- Sampling frequency:
    - Initial and ongoing testing during works

6.3 Monitoring

- Monitor:
    - Adjacent structures
    - Ground movement
- Use independent monitoring system

7. TESTING

7.1 Load Testing

- Static load testing:
    - Compression / tension / lateral
- Reaction system:
    - Adequate and stable
- Load measurement:
    - Calibrated equipment required

7.2 Acceptance Criteria

- Based on:

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    - Load test results
    - Settlement limits
    - Structural integrity

8. HEALTH, SAFETY AND ENVIRONMENT

- Minimize:
    - Noise and vibration
    - Disturbance to surroundings
- Protect:
    - Adjacent structures
    - Utilities
- Prevent environmental contamination

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E05 - IN SITU CONCRETE CONSTRUCTION GENERALLY

To be read with Preliminaries/General Requirements.

215 CONTRACTOR'S STRUCTURAL DETAILING OF REINFORCEMENT

- Responsibility: Prepare reinforcement drawings and schedules for all structural members.
- Requirement: Complete the detailing/ scheduling of reinforcement in accordance with the designated code of practice.
- Design information:
  - Designed reinforcement: As per design drawings.
  - Additional reinforcement: Provide and adjust spacing of reinforcement as required by designated code of practice for the control of cracking.
- Reinforcement:
  - Order of priority when clashes occur: Continuity of column steel followed by primary beam steel, followed by secondary beam steel.
  - Other detailing requirements: Use 150 mm high kickers in columns and walls.

220 STRUCTURAL DESIGN PROVIDED

- Description: as per Preliminaries and General Requirements.
- Requirements:
  - Generally: As section B50.
  - Additional requirements: None.
- Production/ execution records: In accordance with the designated code of practice.

223 STRUCTURAL DRAWINGS AND SCHEDULES

- Standards:
  - Drawings: To BS EN ISO 3766 and 'Standard method of detailing structural concrete' published by the Institution of Structural Engineers.
  - Reinforcement schedules: To BS 8666.

225 TEMPERATURE RECORDS

- Requirement: Throughout period of concrete construction record:
  - Daily: Maximum and minimum atmospheric shade temperature, temperature at intervals of four hours (maximum).
  - Under adverse temperature conditions: Temperature at commencement and end of placing.
- Equipment: Submit proposals.
  - Location: In the shade, close to the structure.

235 OPENINGS, INSERTS AND FIXINGS

- Requirement: Collate all information.
- Submit: Details where openings, inserts and fixings can only be accommodated by adjustments to reinforcement.
- Locate reinforcement: To ensure specified minimum cover at openings and inserts and to be clear of fixing positions.

250 STRUCTURAL TESTING

- Requirement:
  - For finished existing structures: the tests include:1-Load testing;2-Core testing according to BS EN 12504-1; 3-Ultrasonic pulse velocity testing according to BS EN 12504-4; 4-Gamma ray testing; 5-Rebound hammer testing according to BS EN 12504-2, and as per section E10.

  - For in situ early strength testing of concrete, the tests should be fully complied with BS EN 12504-3 and section E10.
- Method/ standard: Submit proposals.
  - Timing: For preliminary laboratory tests, period before commencing construction of structural element. For in situ testing and laboratory compliance testing describe maturity of concrete at time of testing.
- Report: as per preliminaries.
  - Submission: Within five working days of testing.

290 ACCURACY OF CONSTRUCTION
- Setting out: To BS 5964-1.
- Geometrical tolerances: To BS EN 13670, Tolerance Class 1.
  - Conflicts: Notwithstanding tolerances specified elsewhere, do not exceed requirements for compliance with the designated code of practice.
  - Substitution of alternative requirements: None.

300 LEVELS OF STRUCTURAL CONCRETE FLOORS
- Tolerances (maximum):
  - Level of floor: As Preliminaries and general requirements
  - Steps in floor level: Not applicable.

310 SURFACE REGULARITY OF CONCRETE FLOORS TO BS EN 13670, BS EN 13892-3, BS EN 13318 - GENERAL
- Standard: To BS EN 13670, BS EN 13892-3, BS EN 13318, and as per section E20.
- Measurement: From underside of a 2 m straightedge (between points of contact) placed anywhere on surface and using a slip gauge.

410 IN SITU CONCRETE CONSTRUCTION - SUPERVISION/ CHECKING
- Standard: To BS EN 13670, Execution Class 1.

420 LIQUID RETAINING AND CONTAINMENT CONCRETE CONSTRUCTION
- Description: trenches and the like.
- Form of construction: To BS EN 1992-3, Tightness Class 2.

430 SURFACE CRACKING OF CONCRETE VISIBLE ON FACADE, LIQUID RETAINING OR CONTAINMENT CONCRETE CONSTRUCTION WATERTIGHT CONCRETE CONSTRUCTION
- Method of measurement**:** graduated magnifying devices**.**
- Maximum crack width: 0.3 mm**.**
- Action: Should cracks occur that are wider than the maximum crack width:
  - Survey: Frequency and extent of such cracks and investigate cause.
  - Report: Findings together with recommendations for rectification.
  - Final action: Submit proposal for Engineer’s approval.

E10 - MIXING/CASTING/CURING IN SITU CONCRETE

To be read with Preliminaries/General Requirements.

CONCRETE

101 SPECIFICATION

- Concrete generally: To BS EN 206/BS 8500-2, BS EN 1992-1-1.
- Exchange of information: Provide concrete producer with information required by BS 8500-1, clauses 4 and 5, and BS EN 206.

149 PRESCRIBED CONCRETE FOR REINFORCED CONCRETE ELEMENTS to BS 8500:

- Compressive strength class (cylinder/ cube minimum): C40/50
- Fibres: Not required**.**
- Coarse Aggregates: Crushed and well graded, non-reactive, coarse aggregate material to BS EN 12620 and meeting the requirements of clause 310.
  - Size (maximum): 20 mm**.**
  - Coarse recycled aggregates: Not permitted.
- Fine Aggregates: natural sand material alone or combined natural sand with washed crushed sand, to BS EN 12620 and meeting the requirements of clause 310
- Special requirements for cementitious combinations: to EN 197-1 Type CEM I 42.5N or Type CEM II/A-L 42.5N, as specified under Clause 313**.**
- Special requirements for cement/ combinations: Silica fume (5% to 10% of cementitious weight) to EN 13263-1, Fly ash (25% to 35% of cementitious weight) or GGBS (36% to 65% of cementitious weight) may need to be added to the substructure concrete mixes to achieve the specified permeability test requirements, if required and as directed and approved by the Engineer.
- Consistence class: S4.
- Chloride class: CL 0.15.
- Admixtures: To EN 934-2 Plasticising / water reducing, Retarding, Super plasticising, and Water resisting to be added as per manufacturer recommendations, as directed and approved by the Engineer and based on satisfactory trial mixes.
- Design chemical/chloride class: XC2-XC4/DC-1. to be further validated based on site specific investigation.
- Additional mix requirements:
  - Minimum Cementitious Content: 400**.**
  - Maximum Water to Cementitious Ratio (W/C): 0.4**.**
  - Permeability level: Low Permeability**.**
  - Air Content: 2% maximum

150 PRESCRIBED CONCRETE FOR REINFORCED CONCRETE ELEMENTS to BS 8500:

- Compressive strength class (cylinder/ cube minimum): C30/37
- Fibres: Not required**.**
- Coarse Aggregates: Crushed and well graded, non-reactive, coarse aggregate material to BS EN 12620 and meeting the requirements of clause 310.
  - Size (maximum): 20 mm**.**
  - Coarse recycled aggregates: Not permitted.
- Fine Aggregates: natural sand material alone or combined natural sand with washed crushed sand, to BS EN 12620 and meeting the requirements of clause 310
- Special requirements for cementitious combinations: to EN 197-1 Type CEM I 42.5N or Type CEM II/A-L 42.5N, as specified under Clause 313**.**

- Special requirements for cement/ combinations: Silica fume (5% to 10% of cementitious weight) to EN 13263-1, Fly ash (25% to 35% of cementitious weight) or GGBS (36% to 65% of cementitious weight) may need to be added to the substructure concrete mixes to achieve the specified permeability test requirements, if required and as directed and approved by the Engineer.
- Consistence class: S4.
- Chloride class: CL 0.15.
- Admixtures: To EN 934-2 Plasticising / water reducing, Retarding, Super plasticising, and Water resisting to be added as per manufacturer recommendations, as directed and approved by the Engineer and based on satisfactory trial mixes.
- Design chemical/chloride class: XC2-XC4/DC-1. to be further validated based on site specific investigation.
- Additional mix requirements:
  - Minimum Cementitious Content: 360**.**
  - Maximum Water to Cementitious Ratio (W/C): 0.4**.**
  - Permeability level: Low Permeability**.**
  - Air Content: 2% maximum

151 PRESCRIBED CONCRETE FOR PLAIN CONCRETE (BLINDING) to BS 8500

- Compressive strength class (cylinder/ cube minimum): C15/20
- Aggregates:
  - Size (maximum): 25 mm**.**
  - Coarse recycled aggregates: Not permitted**.**
  - Coarse Aggregates: Crushed and well graded, non-reactive, coarse aggregate material to BS EN 12620, meeting the requirements of clause 310**.**
  - Fine Aggregates: natural sand material alone or combined natural sand with washed crushed sand, to BS EN 12620 and meeting the requirements of clause 310.
- Special requirements for cement/ combinations: to EN 197-1 Type CEM I 42.5N or Type CEM II/A-L 42.5N.
- Consistence class: S3.
- Chloride class: Normal.
- Admixtures: EN 934-2.
- Additional mix requirements:
  - Minimum Cementitious Content : 280 kg/m3**.**
  - Maximum Water to Cementitious Ratio (W/C): 0.55.
  - Air content: 2% maximum

195 CYCLOPEAN CONCRETE

- Definition: Concrete used as backfilling for structural excavation shall be cyclopean concrete.
- Compressive strength: similar to the Blinding Concrete.
- Minimum Cementitious Content: similar to the Blinding Concrete.
- Maximum Water/Cementitious ratio: similar to the Blinding Concrete.
- Cement/Cementitious combination: similar to the Blinding Concrete.
- Constituents: Plums used in cyclopean concrete shall consist of non-reactive broken stone spalls or boulders ranging in size from 200mm to 300mm. They shall be free from sharp or angular edges and shall not form more than 30% of the total volume of concrete. They shall be evenly graded and shall be soaked in water prior to incorporation in the mix. Plums shall be evenly distributed in the concrete mix and with minimum cover of 70 mm.

MATERIALS, BATCHING AND MIXING

215 READY-MIXED CONCRETE

- Ready mixed concrete: concrete mixed outside the site and transported to it is to be batched and mixed in accordance with the requirements of BS 8500-1, BS 8500-2, and BS EN 206.
- Production plant: A firm experienced in manufacturing ready-mixed concrete products currently certified and accredited to BS EN ISO/IEC 17065 or equivalent international standard for production facilities and equipment, and product conformity certification of ready-mixed concrete.
- Source of ready-mixed concrete: Obtain from one qualified source/batching plant, approved by the Engineer.
- Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, each aggregate from one source, and each admixture from the same manufacturer.
- Delivery time limitations:
  - When air temperature is between 30 deg. C and 32 deg. C, delivery time from the time water is added to the mix until it is placed in its final position in the form shall not exceed 60 minutes.
  - When air temperature is above 32 deg. C, delivery time shall not exceed 45 minutes.
- Before discharging concrete at the point of delivery, provide the Engineer with a delivery ticket for each batch of concrete containing the following information as minimum:
  - Name or number of off-site concrete depot.
  - Serial number for ticket.
  - Date.
  - Time of dispatch.
  - Truck number.
  - Name of supplier.
  - Grade or mix description of concrete.
  - Type of cement.
  - Cement content.
  - Water/cement ratio.
  - Nominal maximum size of aggregate.
  - Source of aggregate, maximum size, weight of fine and coarse aggregate.
  - Type or name of admixture, if included.
  - Quantity of concrete in cubic meters.
  - Amount of concrete in cubic meter.

216 TESTING AGENCY QUALIFICATIONS

- An independent testing agency, acceptable to Engineer, ISO certified and qualified according to international standards to conduct the testing indicated.
- Personnel conducting field tests shall be qualified as international Concrete Field Testing Technician, according to an approved certification program.
- Personnel performing laboratory tests shall be an internationally certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician.
- Testing Agency laboratory supervisor shall be an internationally certified Concrete Laboratory Testing Technician.

218 SITE MIXED CONCRETE

- Design concrete mixes to the requirements of EN 206, and BS 8500-1 and BS 8500-2.
- Evidence of suitability: for each mix submit in writing details of:
  - proposed quantities of each ingredient per cubic metre of compacted concrete
  - Evidence to show that proposed constituent materials and method of manufacture will produce concrete of required quality.

- Trial mixes are to be prepared for testing and approval by the independent testing agency, one month prior to commencing concreting.
- Approval: do not use mixes before submitted information and evidence has been approved. Such approval will not prejudice the requirement that mixes are to comply with the Specification.
- Make adjustments to percentage of fine aggregate to allow for:
  - Fineness zone of material
  - Workability requirements
  - Bulking of damp sand if measuring by volume.
- Enrichment of mix: subject to approval the aggregate/cement ratio may be reduced by up to 10% for first layer of concrete in walls. Do not alter water/cement ratio.
- Control of colour: obtain approval before altering proportions or grading of concrete exposed in finished work.
- Admixtures: Approved admixtures shall be used strictly in accordance with the manufacturer's instructions.
- Retarding water reducing admixtures may be used in large volumes of concrete subject to approval and are to be used when instructed by the Engineer.
- Water reducing admixtures (Plasticizer): to be used in the production of all reinforced concrete, as approved by the Engineer, unless otherwise specified.
- In case of concrete contains silica fume with a density between 400-720 kg/cu. m, the mixing time shall be 50 percent greater than the requirement for concrete without silica fume.
- Whenever mixing is to be suspended for half an hour or longer, the drum of the mixer shall be thoroughly washed out with clean water. Provide a competent operator who shall be in continuous control of the mixer. No retempering of concrete, which has partially hardened, by the addition of cement, aggregate, or water shall be allowed.
- Provide batch ticket for each batch discharged and used in the Work, indicating Project identification name and number, date, mix type, mix time, quantity, and amount of water introduced.

225 CHANGES TO SPECIFICATION

- Changes to specification of fresh concrete (outside concrete producer's responsibility): Prohibited.
- Do not add water or admixture to concrete during delivery, at Project site, or during placement.

230 INTERRUPTION OF SUPPLY DURING CONCRETING

- Elements without joints: Where elements are detailed to be cast in a single pour without joints, make prior arrangements for a back-up supply of concrete.
- Elsewhere:
  - Preparation: Manage pour to have a full face, and have materials available to form an emergency construction joint while concrete can still be worked.
  - Before pour is completed: Submit location and details of joint, make proposals for joint preparation.

310 AGGREGATES

- Normal-Weight Aggregates: Aggregates shall be from approved sources and shall conform to the requirements of BS EN 12620, from the same source for entire project, uniformly graded.
  - Coarse Aggregate: Coarse aggregate size shall be as specified, and those retained on a 5mm sieve and shall consist of crushed or uncrushed gravel or crushed stone and shall be selected, re-crushed, finish screened and washed with water meeting the requirements of Paragraph 311 as necessary, to comply with the following:

Frequency of Tests	Test Description	Standard	Limit
1 per 30-days	Los Angeles Abrasion Loss	BS EN 1097-2	30% maximum
1 per 30-days	Micro-Deval Coefficient, M_{DE}	BS EN 1097-1	20% maximum
1 per 30-days	Impact Value	BS EN 1097-2	22% maximum
1 per day	Fines Content	BS EN 933-1	1.0% maximum
1 per 7 days	Water Absorption	BS EN 1097-6	2.0% maximum
1 per 3 days	Chlorides as Cl	BS EN 1744-1	0.03% maximum*
1 per 3 days	Sulphates as SO3	BS EN 1744-1	0.3% maximum*
1 per 30 days	Magnesium Sulphate Soundness Loss (5 cycles)	BS EN 1367-2	10.0% maximum
1 per 7 days	Flakiness Index	BS EN 933-3	25% maximum
1 per 7 days	Elongation Index	BS 812	25% maximum
1 per 7 days	Shape Index	BS EN 933-4	25% maximum
1 per source	Reactive Silica	BS 812-123	Non-reactive as per BS EN 12620 and BS 8500
1 per 7 days	Specific gravity		Minimum 2.6
1 per each batch	Moisture Content		
1 in 7 days	Shell Content	BS EN 933-7	5% maximum
1 in 3 days	Sieve analysis	BS EN 933-1	Clause 4.3 of BS EN 12620
1 in 30 days	Drying Shrinkage	BS EN 12620 cl. 5.7 BS EN 1367-4	0.05% maximum

* The limits specified in Paragraph 420 for the total salt content of the concrete shall not be exceeded.

– Fine Aggregate: Fine aggregate, those passing a 5mm sieve, shall consist of natural sand with rounded or surrounded particles alone or in combination with crushed gravel, crushed stone and shall be washed as necessary to comply with the following:

Frequency of Tests	Test Description	Standard	Limit
1 per 7 days	Organic Matter/Humus Content	BS EN 1744-1	Lighter than standard colour
1 per day	Fines Content	BS EN 933-1	maximum 3% for natural sand and 5% for crushed sand with no plastic fines
1 per 7 days	Water Absorption	BS EN 1097-6	2.0% maximum
1 per 3 days	Chlorides as Cl	BS EN 1744-1	0.06% maximum*
1 per 3 days	Sulphates as SO_3	BS EN 1744-1	0.30% maximum*
1 per 30 days	Magnesium Sulphate Soundness Loss (5 cycles)	BS EN 1367-2	10.0% maximum
1 per 7 days	Methylene Blue	BS EN 933-9	1.0 (g/kg) maximum
1 per day	Sand equivalent	BS EN 933-8	75% minimum
1 per 7 days	Shell content	BS EN 933-7	5% maximum
1 per source	Reactive Silica	BS 812-123	Non-Reactive as per BS EN 12620 and BS 8500
1 in 3 days	Sieve analysis	BS EN 933-1	Clause 4.3 of BS EN 12620 standard
1 per 30 days	Drying Shrinkage	EN 12620 cl. 5.7 EN 1367-4	0.05% maximum

* The limits specified in Paragraph 420 for the total salt content of the concrete shall not be exceeded.

- Certification: Obtain from each proposed source of supply Test Certification to confirm that the aggregates comply with the above requirements. The following information shall be provided:
  - Quarry location.
  - Aggregate type.
  - Petrographic analysis report.
  - Grading curve.
  - Shape and surface texture.
  - Flakiness index.
  - 10 percent fines value.
  - Impact test.
  - Shell content.
  - Chloride and sulphate content.
  - Relative density.
  - Water absorption value and moisture content.
  - Silt, clay, and dust content.
  - Results of reactive silica tests.
  - Organic impurities (fine aggregate only).
  - Sand equivalent.
- Testing:
  - When a source of supply for each aggregate type had been established, samples of materials delivered to Project site shall be taken for testing in accordance with BS 812 or BS EN standard test methods as follows:

- Tests for clay, silt and dust, and sieve analysis shall be carried out for every 20 tons of fine aggregate and every 40 tons of coarse aggregate.
- Chemical analyses shall be carried out on every 100 tons of aggregate.

- The Engineer shall have the right to call for additional samples at any time for testing of aggregates delivered to the Project site or of aggregates at the source of supply in order to confirm that the aggregates meet the above requirements.
- Transportation: During transportation to the Project site, all aggregates shall be protected from wind-borne contaminants. If these contaminants are present at time of delivery to the Project site, then the aggregates shall be washed with water meeting the requirement of Paragraph 311. Transport vehicles shall be cleaned of possible contamination due to previous use.
- Storage: Aggregates shall be stored (under shade) on hard concrete floors or other approved materials having sufficient slope to ensure adequate drainage of aggregate before being used for concrete and each size and type shall be stored in separate heaps without intermixing. Storage shall prevent contamination of the aggregates by foreign material including wind-blown dust. Fine and coarse aggregates shall be separated by permanent substantial partitions. Methods of storing, shading and cooling aggregates shall be approved by the Engineer.
- Lightweight aggregates:
  - Standard: BS EN 13055-1.
  - Nominal Size: 10mm.

311 WATER

- Water used for mixing concrete, ice production, washing and cooling aggregates, and curing concrete shall be potable water complying with BS EN 1008, free from impurities, oil, acid, salts, alkali, organic matter, and other potentially deleterious substances. The chloride content shall not exceed 500 ppm.
  - Once a source of satisfactory supply has been established, further tests shall be made daily with a portable electrical conductivity probe calibrated against the satisfactory supply. If the conductivity exceeds that of the satisfactory supply, then further chemical tests shall be performed.
  - The limits specified in Paragraph 420 for the total salt content of the concrete shall not be exceeded.
- Non-potable water may be used when potable water is not available provided the impurities do not exceed the values given below:
  - Chloride as (Cl-): 500 ppm to ASTM D512.
  - Sulphates as SO4: 1000ppm to ASTM D516.
  - Alkalis as (Na2O + 0.658 K2O): 600ppm to ASTM C1602/C1602M.
  - Total solids: 50000ppm to ASTM C1602/C1602M.

313 CEMENT

- Cements: obtain from approved sources. Delivery of cement is to be in sealed and branded containers in batches not exceeding 100 tonnes or in purpose made bulk delivery vehicles.
- Portland cement: to EN 197-1 type CEM I 42.5N or Type CEM II/A-L 42.5N, to be used in superstructure concrete.
- Portland cement: to EN 197-1 type CEM I 42.5N or Type CEM II/A-L 42.5N, with C3A content ranging from 5% to 8%, to be used in substructure concrete.
- The heat of hydration of cement to be used in massive concrete structures shall not exceed 260kg/kj at 7-days when tested according to EN 196 standard.
- Sulphate resisting Portland cement: to EN 197-1Type CEM I 42.5N/SR5, shall be used for all sewage concrete elements. As an alternative cement Type CEM I 42.5N or Type CEM II/A-L 42.5N in combination with fly ash or GGBS can be used in the concrete mixes.
- High Alumina Cement: do not use.

- Cementitious additives: cementitious additives such as Silica fume (SF) to EN 13263-1, fly ash to EN 450-1 or GGBS to EN 15167-1, may be necessary to be added to the concrete mixes individually or in combination, to meet the specified strength, permeability and heat of hydration requirements and provide dense concrete with "Low" permeability level.
- Cementitious Materials: Limit percentage, by weight, of cementitious materials other than Portland cement in concrete as follows:
    1. Fly Ash : 35% maximum
    2. GGBS 65% maximum.
    3. Silica Fume 10% maximum.

315 AGGREGATES FOR EXPOSED VISUAL CONCRETE

- Limitations on contaminants: Free from absorbent particles which may cause 'pop outs', and other particles such as coal and iron sulphide or the like which may be unsightly or cause unacceptable staining**.**
- Colour: Consistent, colour variation to be between 3 to 5%.
- Supply: From a single source and maintained throughout the contract.
- Samples: Submit on request.

325 MATERIALS FOR EXPOSED VISUAL CONCRETE

- Alterations to sources, types and proportions: Submit proposals to Engineer's approval.

415 ADMIXTURES

- Admixtures: Use admixtures according to the manufacturer's written instructions and Engineer's approval.
- Use water-reducing admixture or high-range water-reducing admixture (superplasticizer) to EN 934-2 in concrete, as required, for placement and workability.
- Use water-reducing and retarding admixture to EN 935 when required by high temperatures, low humidity, or other adverse placement conditions.
- Use water-reducing admixture to BS EN 934-2, in pumped concrete, concrete for heavy-use industrial slabs and parking structure slabs, concrete required to be watertight, and concrete with a water-cementitious materials ratio below 0.50.
- Use Third generation admixture, PolyCarboxylate Ether to BS EN 934-2, if silica fume is used in the concrete or if self-consolidated concrete is required.
- Calcium chloride and admixtures containing calcium chloride: Do not use.

420 TOTAL SALT CONTENT:

- Chlorides: The water soluble chloride content of the concrete from all sources, expressed as chloride ion, shall not exceed 0.15 percent by weight of dry cement, inclusive of cementitious additives, when tested in accordance with BS 1881-124.
- Sulphates: The total sulphate content of the concrete from all sources, expressed as SO3, when tested in accordance with BS 1881-124 and BS EN 1744-1, shall not exceed 3 percent by weight of dry cement, inclusive of cementitious additives.

430 PIGMENTS FOR COLOURED CONCRETE

- Standard: To BS EN 12878.
    - Synthetic mineral-oxide pigments or coloured water-reducing admixtures; colour stable, free of carbon black, non-fading and resistant to lime and other alkalis.
    - Colour: Refer to AR drawings for colour specification.

490 PROPERTIES OF FRESH CONCRETE

- Adjustments to suit construction process**:** Maintain conformity to the specification.
- The fresh properties of concrete shall be determined during the trial mix design stage and for the cast concrete. The following minimum testing on fresh concrete shall be conducted:
    - Slump/Slump retention: to BS EN 12350-2

- Density: BS EN 12350-6
- Air content: BS EN 12350-7
- Degree of Compactability: to BS EN 12350-4
- Concrete Mixing Temperature

491 PATCHING MORTAR

- Mix dry-pack, consisting of one part Portland cement to two and one half parts fine aggregates passing a 1.2mm sieve, using only enough water for handling and placing.

495 MISCELLANEOUS CONCRETE ITEMS

- Filling in: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete work.
- Curbs: Provide monolithic finish to interior curbs by stripping forms while concrete is still green and by steel-trowelling surfaces to a hard, dense finish with corners, intersections, and terminations slightly rounded.
- Equipment bases and foundations:
  - Coordinate sizes and locations of concrete bases with actual equipment provided.
  - Construct concrete bases as shown on drawings; and extend base not less than 150mm in each direction beyond the maximum dimensions of supported equipment unless otherwise indicated or unless required for seismic anchor support.
  - Minimum compressive strength: same strength as the main structural elements.
  - Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 450mm centres around the full perimeter of concrete base.
  - For supported equipment, install epoxy coated anchor bolts that extend through concrete base, and anchor into structural concrete substrate.
  - Prior to pouring concrete, place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - Cast anchor bolt insert into bases. Install anchor bolts to elevations required for proper attachments to supported equipment.
- Steel pan stairs: Provide concrete fill for steel pan stair treads, landings, and associated items. Cast-in inserts and accessories as shown on Drawings. Screed, tamp, and trowel finish concrete surfaces.

PROJECT TESTING/ CERTIFICATION

505 PROJECT TESTING OF CONCRETE - GENERAL

- Testing: To BS EN 206 and BS 8500
  - Nonconformity: Obtain instructions immediately.
- Recording: Maintain complete correlated records including:
  - Concrete designation.
  - Sampling, site tests, and identification numbers of specimens tested in the laboratory.
  - Location of the parts of the structure represented by each sample.
  - Location in the structure of the batch from which each sample is taken.

507 INITIAL PROJECT TESTING OF CONCRETE

- Trial mixes are to be prepared for testing and approval one month prior to commencing concreting.
- The Engineer will review the Contractor's trial - mixes and break the test cylinders or test cubes at seven (7) and twenty-eight (28) days. The Engineer will then determine which of the trial-mixes shall be used. If none of the trial-mixes for a class of concrete meets the specifications, the Engineer will direct the Contractor to prepare additional trial-mixes. No class of concrete shall be prepared or placed until its job-mix proportions have been approved by the Engineer.

- The approval of the job-mix proportions by the Engineer, or his assistance to the Contractor in establishing those proportions, in no way relieves the Contractor of the responsibility of producing concrete which meets the requirements specified in these specifications.
- Absorption and permeability testing: shall be carried out on substructure concrete samples at the trial mix design stage.
- Tests: Refer to section 508.

508 REGULAR PROJECT TESTING OF CONCRETE

- Generally: sampling, testing and assessment of compliance are to be as specified in compliance with BS EN 206 and BS EN 12390 unless otherwise specified or approved.
- Compliance testing: testing and checking are to be in the presence of or as agreed with the Engineer. Submit results to the Engineer within 2 working days of completion of each test.
- Testing authority: testing shall be carried out by an independent testing agency, approved by the Engineer.
- Atmospheric thermometer: provide maximum and minimum thermometer in approved position on the site for measuring atmospheric shade temperature.
- Soil thermometer: provide soil thermometer for measuring concrete and ground temperatures.
- Test apparatus: keep in good repair until concrete work is completed.
- Samples: to ensure adequate quality control of mixes on the site take samples of each mix of concrete from every mixing point in accordance with the recommendations and the requirements of EN 12350-1, EN 12504, EN 12390.
- Sampling rate: take samples for compliance testing of compressive strength for each mix as follows:
  Initially 4 random samples during each of the first 10 days of using mix
  Thereafter not less than one sample during each day of using mix.
  Unless otherwise approved each sample is to represent a volume of not more than 20 m3. Higher rates of sampling and testing may be instructed at: start of work to establish level of quality, during periods of production when quality may be in doubt or during the pouring of column, cantilever and other critical elements. Subject to approval sampling rates may be reduced when high and consistent quality has been established.
- Water/cement ratio: where works slump testing is specified for assessing compliance with specified free-water/cement ratio, submit results of preliminary tests to establish relationship between the two properties and obtain approval.
- Slump tests: carry out in accordance with EN 12350-2 at required times and when test cylinders/cubes are prepared.
- Compressive strength testing: a minimum of six test cylinders or test cubes if approved are to be made for each sample. Test three at 7 days and three or more at 28 days. The strength at 28 days must not be less than the compressive strength specified for the relevant class of concrete.
- Records: indicate on works test records parts of structure represented by samples tested. Keep records on the site.
- Failure of concrete mix: if concrete mix fails to achieve specified criteria or to pass specified tests arrange for design of mixes to be adjusted and tests repeated until mixes are accepted by the Engineer.
- Failure of concrete work: if workmanship and finished work are not in accordance with specified requirements then the Engineer may require testing of drilled cores and/or loading tests to be carried out on any part of the structure after completion. The Contractor is to arrange for an approved independent testing authority to carry out such required tests. The costs of all such tests and testing shall be borne by the Contractor.
- Procedure for drilling and testing cores is to comply with EN 12504-1. Evaluation of adequacy of concrete in area represented by core tests is to comply with EN 13791.
- Static load tests are to be carried out and evaluated in accordance with the requirements of EN 12390-3, as requested by the Engineer.

- Tests for consistence class of self-compacting concrete: Viscosity class by v-funnel test to BS EN 12350-9.
- Consistence testing period: 4 h.
- Other requirements: Cubes for early age strength testing to be stored under same conditions as concrete in members.

509 ABSORPTION TEST

- The absorption of the hardened concrete from the trial mixes for structural grades shall be tested as a measure of the concrete's ability to resist the ingress of aggressive salts. No absorption tests shall be required for blinding or mudmat concrete. Absorption tests shall be in accordance with modified BS 1881: Part 122 and tested at 28-days.
  - The mean of the corrected absorption figure for each concrete grade shall be calculated and the absorption of the concrete mixes shall be acceptable if the mean absorption is less than 2.0 percent, at 30 minutes for "Low" permeability level.

510 DEPTH OF PENETRATION PERMEABILITY TESTS

- Carry out to BS EN 12390-8 as a measure of water permeability on concrete samples before the mix design or manufacturing method are approved.
- The tests shall be carried out in accordance with EN 12390-8 at age 28 days and the maximum value of penetration shall not exceed 15 mm for "Low" permeability level.

511 RAPID CHLORIDIE ION PENETRATION TEST

- The chloride permeability of the concrete shall be determined using cores taken from the concrete trial samples, in accordance with ASTM C1202 "Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration" or AASHTO T277 and the limit of 2000 Coulombs shall not be exceeded at 28-days for "Low" permeability level concrete.

512 EVALUATION OF CONCRETE PERMEMABILITY TEST

- The concrete will be deemed to comply with the permeability requirements of this specification if minimum of two test results comply with the limits indicated in sub clauses 509, 510, and 511. If the concrete trial samples failed to meet the above requirements, then the concrete mix represented by such sample shall be deemed not to comply with the permeability requirements and new and adjusted concrete trials shall be carried out by the Contractor, as directed by the Engineer.

513 TEST MIXES FOR BLINDING OR MUDMAT CONCRETE

- Concrete for blinding or mudmat shall be a designed mix with the specified design strength. The trial mix proportions shall be left to the discretion of the Contractor. Once they have been chosen, three separate test mixes shall be made with those proportions and three 150mm test cylinders or cubes shall be made from each mix for testing at 28 days. The trial mix proportions and water/cement ratio shall be approved if the average cylinder strength of the nine cylinders is not less than 20N/sq.m (25 N/sq.m for cube samples).
- No production test shall be made for this grade of concrete but the Engineer will monitor the mix proportions and water/cement ratio.

520 TESTING LABORATORY

- Laboratory: Accredited by UKAS, ISO or other international equivalent and approved by the Engineer.
  - Name and accreditation reference number: Submit well in advance of making trial mixes or concrete for use in the works.

530 TESTS RESULTS

- Submission of reports: Within one day of completion of each test.
  - Number of copies: Three**.**

- Reports on site: A complete set, available for inspection.
- Reports shall include the following as applicable to each test and inspection:
  - Date, time, location, and volume of pour.
  - Ambient temperature and humidity.
  - Concrete temperature (at time of placement).
  - Cement type and manufacture.
  - Concrete type and class.
  - Aggregate type and source.
  - Admixture details.
  - Water/cement ratio.
  - Identification of test cylinder/cube.
  - Name of concrete testing service.
  - Date and time of sampling.
  - Method of compaction.
  - Date of testing and results of test.
  - Age of sample in days, weight in grams, density in kg/cu. m.
  - Crushing load in newton and crushing strength in N/sq. mm.
  - Signatures of person preparing cylinder/cube and of person crushing cylinder/cube.
  - Results of compressive strength.
  - Compressive breaking strength, and type of break for both 7- and 28-days tests.

550 BROKEN CUBES FROM FAILED STRENGTH TESTS

- Nonconformity: Keep separately the pieces of each cube which fail to meet the conformity requirements for individual results.
- Period for keeping cubes: Obtain instructions.

PLACING/ COMPACTING/ CURING AND PROTECTING

610 CONSTRUCTION/ SEQUENCE/ TIMING REQUIREMENTS

- As Specified in Preliminaries and General Requirements.

620 TEMPERATURE OF CONCRETE

- Application: Concrete slabs with a thickness exceeding 1500mm**.**
- Objective: Limit maximum temperature of concrete to minimize cracking during placing, compaction and curing. Take account of:
  - High temperatures and steep temperature gradients: Prevent build-up during first 24 hours after casting. Prevent coincidence of maximum heat gain from cement hydration with high air temperature and/ or solar gain.
  - Rapid changes in temperature: Prevent during the first seven days after casting**.**
- Concrete temperature shall be measured 50 mm below the surface prior to and at the point of placement and recorded on the pour card for each pour. There shall be one test hourly when air temperature is 4 deg.C and below and when air temperature is 27 deg.C and above, and one test for each set of compressive-strength specimens. Concreting shall stop if the temperature of the concrete does not meet the requirements of below paragraphs.
- Cold-Weather Placement:
  - Protect concrete work from physical damage or reduced strength that could be caused by low temperatures.
- Hot-Weather Placement: as follows:
  - Maintain concrete temperature below 32 deg. C at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

- Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.
- No concreting operation shall be carried out at ambient temperature of 40 deg. C or more.
- Cover reinforcing steel with water-soaked burlap if it becomes too hot, so that steel temperature will not exceed the ambient air temperature immediately before embedding in concrete.
- Fog spray forms, reinforcing steel, and subgrade just before placing concrete. Keep subgrade moisture uniform without puddles or dry areas.
- Use water-reducing retarding admixture when required by high temperatures, low humidity, or other adverse placing conditions, as acceptable to the Engineer.
- Shade mixing plant and trucks, aggregates, water tank, and cement silo.
- Paint white the mixing plant, trucks, water tank, and cement silo.
- Insulate the water tank and supply piping.
- Provide necessary shades over and around the concrete being poured to prevent sun rays from coming into direct contact with the surface of the concrete and the formwork for a period of about 7 days (minimum from the time of pouring concrete).
- Concrete placing shall be completed as quickly as possible to reduce transit time.
- Curing of exported concrete shall be immediately carried out.

- Proposals for meeting objective: Submit method statements for engineer's approval.
- For curing measures, refer to articles 810, 811, 815, 817, 818, and 820

630 PREMATURE WATER LOSS

- Requirement: Prevent water loss from concrete laid on absorbent substrates.
  - Underlay:
    Polyethylene sheet: 250 micrometres thick.
    Building paper: To BS 1521, grade B1F
  - Installation: [lap edges 150 mm].

640 CONSTRUCTION JOINTS

- Location of joints:
  - joints in water resistant construction to be as per drawings, Pours to be continuous between movement joints.
- Submit proposals for Engineer's approval when not shown on drawings.
- Preparation of joint surfaces: As section E40. Remove surface laitance and expose aggregate by lightly brushing and spraying. Joint surface to be clean and damp immediately before placing fresh concrete.

645 SPACING OF CONSTRUCTION JOINTS

- Distance between joints (maximum): 30 m .
- Area of pour (maximum): minimize number of joints.

648 ADVERSE TEMPERATURE CONDITIONS

- Requirement: Submit method statement for protecting concrete when predicted ambient temperatures indicate risk of concrete freezing or overheating.

650 SURFACES TO RECEIVE CONCRETE

- Cleanliness of surfaces immediately before placing concrete: Clean with no debris, tying wire clippings, fastenings or free water.

660 INSPECTION OF SURFACES

- Notice: Give notice to allow inspections of reinforcement and surfaces before each pour of concrete.
  - Period of notice: Obtain instructions.

- Timing of inspections: First inspection when reinforcement fixing is close to completion, second inspection when reinforcement and formwork are ready for concreting.

670 TRANSPORTING

- General: Avoid contamination, segregation, loss of ingredients, excessive evaporation and loss of workability. Protect from heavy rain.
- Entrained air: Anticipate effects of transport and placing methods in order to achieve specified air content.
- Transport and deliver concrete in compliance with BS EN 206 standard.
- Additional requirements: Concrete, after being discharged from the mixer, shall be transported as rapidly as possible to its final position by agitator trucks, which shall prevent adulteration, segregation, loss of workability or contamination of the ingredients. The containers that convey the concrete shall be kept clean and free from hardened or partially hardened concrete.

680 PLACING

- Records: Maintain for time, date and location of all pours.
- Timing: Place as soon as practicable after mixing and while sufficiently plastic for full compaction.
- Temperature limitations for concrete: [32°C (maximum)] and [4.4°C (minimum)], unless otherwise specified.
- Continuity of pours: Place in final position in one continuous operation up to construction joints. Avoid formation of cold joints.
- Discharging concrete: Prevent uneven dispersal, segregation or loss of ingredients or any adverse effect on the formwork or formed finishes.
- Thickness of layers: To suit methods of compaction and achieve efficient amalgamation during compaction.
- Poker vibrators: Do not use to make concrete flow horizontally into position, except where necessary to achieve full compaction under void formers and cast-in accessories and at vertical joints.
- When the continuous placement of concrete in any structural member is interrupted or delayed, for any reason, for a period long enough for the previously partially placed concrete to take its initial set, the Engineer shall declare such a joint a cold joint.
  - In case of cold joint, immediately remove the previously partially placed concrete from the forms. No extra payment will be made for the initial placement or the removal of concrete which is wasted because of a cold joint. The Engineer may suspend all or any part of the subsequent concrete work until he deems the Contractor has corrected the cause for the cold joint occurrence.
  - The Engineer may, with due consideration to the location of the cold joint and/or the importance of the member, allow the Contractor to retain the partially placed concrete and complete the concreting by a subsequent pour, which for permission, the Engineer shall instruct the Contractor to carry out at his own expense some or all of the following measures before completing the pour:
    - Surface laitance shall be removed from the surface of the partially placed concrete by wire brushing or light tooling or by sand blasting as directed by the Engineer without damage to reinforcement and formwork.
    - Shear keys shall be cut in the partially placed concrete. The shape, size and orientation of the shear keys shall be as directed by the Engineer. The reinforcement and formwork shall not be damaged.
    - The cleaned surface of the partially placed concrete shall be coated with an approved bonding agent before placing the subsequent pour.
    - Additives to facilitate bonding shall be added to the concrete used for the subsequent pour.

- Dowel bars of a type and length to be approved by the Engineer shall be installed in the partially placed concrete using non-shrink cement grout or resin grout as directed by the Engineer. The size and spacing of the dowel bars shall be approved by the Engineer. Their installation shall not damage the reinforcement or formwork.
- The partially placed concrete and the subsequent concrete shall be stressed by prestressing bars of a size and type approved by the Engineer to achieve a level of compressive stress at the interface approved by the Engineer. The method of installing the prestressing bars and type of anchors used shall be approved by the Engineer. Unless otherwise agreed by the Engineer, the drill hole shall be grouted with a cement grout containing expanding additive to the manufacturer's recommendations.

682 EMBEDDED ITEMS

- Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
  - Install anchor bolts, accurately located, to elevations required.
  - Install reglets to receive top edge of foundation sheet waterproofing and to receive through-wall flashings in outer face of concrete frame at exterior walls, where flashing is shown at lintels, shelf angles, and other conditions.
  - Install dovetail anchor slots in concrete structures as indicated.

685 CONCRETE DEPOSITING IN WATER

- Concrete shall not be deposited in water.

690 COMPACTING

- General**:** Fully compact concrete to full depth to remove entrapped air. Continue until air bubbles cease to appear on the top surface.
  - Areas for particular attention: Around reinforcement, under void formers, cast-in accessories, into corners of formwork and at joints.
- Consecutive batches of concrete: Amalgamate without damaging adjacent partly hardened concrete.
- Methods of compaction: To suit consistence class and use of concrete.

700 LIGHTWEIGHT AGGREGATE CONCRETE

- Placing and compacting: Prevent flotation of coarse aggregate and formation of excessive blowholes.

720 VIBRATORS

- General: Maintain sufficient numbers and types of vibrator to suit pouring rate, consistency and location of concrete.
- Internal vibration shall be executed in all sections which are sufficiently large to permit the insertion and manipulation of immersion vibrators, previously approved by the Engineer.
- External form vibrators shall be used for external vibration when it is impossible to use internal vibrators, for example in heavily reinforced thin walls, pipes or other precast, small cross-section element, etc. Obtain approval for use.
- Mixed vibration shall be used in the construction of reinforced or prestressed concrete beams. External wall vibrators shall also be used. These shall be mounted on the outside of the formwork after this has been suitably reinforced with ribs of U-bars. The mounting places of the wall vibrators shall be welded to these reinforcements. They must be symmetrically positioned on each side of the beam and produce a rotary movement within the concrete during vibration from the bottom towards the top and from the part placed first towards the part placed last. The network of reinforcing bars and tensioning cables should not move as a result of the vibration. To prevent this from happening, either special ties passing through the formwork walls, or spacers shall be used. It is better, if these last are made of concrete and are of a size and shape that will ensure that the reinforcing and tensioning cables do not move.

- Poker vibrators types and sizes, if needed to be used, shall suit the pour size, density of reinforcement and member dimensions. Poker vibrators shall be inserted into the concrete vertically at regular intervals which shall be no greater than 0.5m, keeping them clear of formwork and concrete previously cast. They shall be inserted quickly and withdrawn slowly. The withdrawal rate shall be not more than 75mm/sec. A cycle of insertion and withdrawal shall be between 10 and 30 seconds.

730 PLASTIC SETTLEMENT

- Settlement cracking: Inspect fresh concrete closely and continuously wherever cracking is likely to occur, including the top of deep sections and at significant changes in the depth of concrete sections.
  - Timing: During the first few hours after placing and while concrete is still capable of being fluidized by the vibrator.
- Removal of cracks: Re-vibrate concrete.

810 CURING GENERALLY

- Requirement: Keep surface layers of concrete moist throughout curing period, including perimeters and abutments, by either restricting evaporation or continuously wetting surfaces of concrete.
  - Surfaces covered by formwork: Retain formwork in position and, where necessary to satisfy curing period, cover surfaces immediately after striking.
  - Top surfaces: Cover immediately after placing and compacting. If covering is removed for finishing operations, replace it immediately afterwards.
- Surface temperature: Maintain above 5°C throughout the specified curing period or four days, whichever is longer.
- Records: Maintain details of location and timing of casting of individual batches, removal of formwork and removal of coverings. Keep records on site, available for inspection.

811 COVERINGS FOR CURING

- Sheet coverings: Suitable impervious material.
- Curing compounds: Selection criteria:
  - Curing efficiency: Not less than 75%.
  - Colouring: [none.
  - Application to concrete exposed in the finished work: Readily removable without disfiguring the surface.
  - Application to concrete to receive bonded construction/ finish: No impediment to subsequent bonding.
- Interim covering to top surfaces of concrete: Until surfaces are in a suitable state to receive coverings in direct contact, cover with impervious sheeting held clear of the surface and sealed against draughts at perimeters and junctions.

812 PREVENTING EARLY AGE THERMAL CRACKING

- Deep lifts or large volume pours: Submit proposals for curing to prevent early age thermal cracking, taking account of:
  - After the concrete has been placed, its peak temperature in any part of the structure shall not be permitted to rise above 70deg C.
  - After the concrete has been placed, the maximum temperature difference between a point at the centre of a concrete section and the adjacent surface shall not be greater than 19 deg. C.
  - Employ effective means such as insulation, selection of appropriate pour cycle times, or heating/cooling as necessary, to ensure that at any time within 21 days after the concrete has been placed, the temperature differential between any point in the freshly placed concrete of any structural element at a distance of 600mm from a construction joint and the corresponding point 600mm from the construction joint in the adjacent previously placed structural element, shall not exceed 19 deg. C.

  - Coefficient of thermal expansion of the concrete
  - Strain capacity of the concrete mix (aggregate dependent).
- Mock-up trial sample for evaluating the variation in concrete temperature:
  - Two mock-up samples of minimum dimensions (to be specified by Engineer depending on dimensions of actual concrete structure) shall be prepared for each trial mix for the purpose of measuring the temperature variation inside the concrete by thermocouples to ensure the above limits are met.
  - Sample preparation, test procedure, and results shall be as approved by the Engineer.

815 ADDITIONAL CURING REQUIREMENT - WATER CURING

- Water to be complying with paragraph 311.
- Commencement of water curing: As soon as practicable after placing and compacting concrete.
  - Surfaces covered by formwork: Expose to water curing as soon as practicable.
  - Top surfaces: Cover immediately with impermeable sheeting to prevent evaporation before commencement of water curing.
- Water curing: Wet surfaces continuously throughout curing period.
  Methods: Mist spray**.**

817 CURING CLASS

- Standard: To BS EN 13670 Curing class 1

818 CURING PERIODS GENERALLY

- Minimum periods: to BS EN 13670, Annex F.8.5 when not otherwise indicated, but not less than seven days.

820 CURING PERIODS

- General: Curing periods are in days (minimum of seven days).
  - Definition of (t): The average surface temperature of concrete in degrees Celsius during the curing period.
- Curing periods for concrete made using CEM1 strength class 42.5 or 52.5, or SRPC class 42.5:
  - Drying winds or dry, sunny weather (relative humidity < 50%): 140 days/ (t+10).
  - Intermediate conditions (relative humidity between 50 and 80%): 100 days/ (t+10).
  - Damp weather, protected from sun and wind (relative humidity > 80%): 100 days/ (t+10).
- Curing periods for concrete made using cements listed in BS8500-1, Table A.6 except for those listed above and for super sulphated cement:
  - Drying winds or dry, sunny weather (relative humidity < 50%): 180 days/ (t+10).
  - Intermediate conditions (relative humidity between 50 and 80%): 140 days/ (t+10).
  - Damp weather, protected from sun and wind (relative humidity > 80%): 100 days/ (t+10).
- Curing periods: For concretes using admixtures or other types of cements/ combinations: Submit proposals.
- Other requirements: Increase curing period by any time during which surface temperature of concrete is less than 5°C.

840 PROTECTION

- Prevent damage to concrete, including:
  - Surfaces generally: From rain, indentation and other physical damage.
  - Surfaces to exposed visual concrete: From dirt, staining, rust marks and other disfiguration.
  - Immature concrete: From thermal shock, physical shock, overloading, movement and vibration.
- Members exposed to strong winds shall be provided with windbreakers. The windbreakers shall, if directed by the Engineer, be kept moist by regular spraying.

E12 - TENSIONED REINFORCEMENT FOR PRESTRESSED CONCRETE

To be read with Preliminaries/General Requirements

MATERIALS AND PRODUCTS

110 PRESTRESSING COMPONENTS

- Prestressing tendons: to BS 5896, as shown on the Drawings.
- Prestressing system: to be as shown on the Drawings. Submit, for approval, full details of proposed prestressing system and names of suppliers of basic materials and components. No system is to be used in the work until approved by the Engineer.
- Anchorages: to be cast type, to BS EN 13391 or other approved standard.

115 GROUT

- Grout for ducts: unless otherwise directed or agreed as a result of grouting trials, is to consist of ordinary Portland cement to BS EN 197-1 and water, in accordance with BS ISO 14824-1.
- Water/cement ratio is to be as low as possible consistent with necessary workability and not higher than 0.45, and not subject to bleeding in excess of 2% after 3 hours or 4% maximum.
- When measured at 18 deg. C in a covered glass cylinder approximately 100 mm diameter with a height of grout approximately 100 mm, water is to be re- absorbed after 24 hours.

WORKMANSHIP

210 GENERALLY

- Prestressing operations: are to be carried out only under the direction of an experienced and competent supervisor and all personnel operating the stressing equipment are to be properly trained in its use.
- Special precautions: against accident are to be taken when working with or near tendons which have been tensioned or are being tensioned.
- Prestressing components generally are to be clean and free from loose rust and mill scale at time of fixing in position and subsequent concreting. Slight rusting of steel is acceptable, but surface is not to be pitted. Components are to be stored in clean, dry conditions.
- Prestressing tendons:
  - All wires or strands stressed at the same time are to be taken from the same parcel; each cable is to be tagged with its number and coil numbers of steel used
  - Do not weld tendons within the length to be tensioned and, unless other methods of cutting are approved by the Engineer, only saw or crop tendons using abrasive disc cutter
  - Build tendons into the work strictly in accordance with requirements for system being employed
  - Tendons are not to be kinked or twisted; individual wires or strands are to be readily identifiable at each end of member; no strand which has become unravelled is to be used in the work.
- Anchorages:
  - Position and maintain anchor cones, blocks and plates during concreting so that centre line of duct passes axially through anchorage assembly
  - Bearing surfaces of anchorages are to be clean prior to concreting and tensioning
  - If proprietary forms of anchorage are used, anchoring procedure is to be strictly in accordance with manufacturer's instructions
  - Allowance for draw-in of tendon during anchoring is to be in accordance with the Engineer's instructions; actual slip occurring is to be recorded for each anchorage.
- Equipment generally: jacks used for prestressing are to be type suitable for system being employed. Check accuracy of load metering equipment to the satisfaction of the Engineer at the start of work each day it is used and whenever equipment is moved to a different location.

- Jacks: provide documentary evidence confirming that all jacks have been fully overhauled and checked by an agent approved by the manufacturer of the equipment. Provide test certificate for each jack indicating that it has been tested and calibrated by the manufacturer or by an approved testing laboratory, up to a load equal to full capacity of jack, within a period of 2 years prior to commencement of prestressing.
- Measuring devises: gauges, load cells, dynamometers and other devices used for measuring stressing force are to have accuracy within +/-1.5%. Pressure gauges are to have capacity and calibrated cell such that working pressure required to stress tendons to full load is indicated within central half of gauge range. Dials are to be read in kilograms or tonnes.
- Calibration of gauges: pressure gauges are to be constructed so that they may be calibrated either directly by an approved testing laboratory or by compressing with a meter gauge which has itself been calibrated by an approved testing laboratory. Provide, for each gauge, a calibration certificate issued by an approved testing laboratory.
- Re-calibration of pressure gauges is to be carried out before use and at intervals of 14 days thereafter. The Engineer may order re-calibration of any pressure gauge at any time should he have reason to suspect damage to or faulty operation of gauge.
- Checking of equipment: check accuracy of all prestressing and load measuring equipment whenever required by the Engineer. Provide facilities suitable, in the opinion of the Engineer, for all checking and calibration of any jacking system comprising jacks and associated load devices, pressure gauges and dynamometers.

220 TESTING OF MATERIALS

- Generally: carry out tests in the presence of the Engineer or his appointed representative.
- Prestressing tendons: initially test for chemical composition, mechanical strength, relaxation and physical characteristics, as per the requirements of BS 5896. Subsequently similarly test samples selected at random by the Engineer from each coil supplied.
- Compression grips, when used, are to be tested to failure using strands to be used in the work. Not less than six compression grips selected at random are to be tested.
- Anchorages: test in accordance with BS EN 13391 and as often as considered necessary by the Engineer.
- Grout mix: test each design mix and each batch mix for longitudinal dimensional change in accordance with BS ISO 14824-3:
- Concrete: prepare test cylinders, cure in similar conditions to the concrete to which they relate and test all as described in section E10, to ascertain when required strength of concrete at transfer has been reached.

230 FIXING CABLE SHEATHS

- Location: tolerance in the location of sheaths is to be +/-3 mm. Maintain sheaths in their correct positions during placing of concrete.
- Joints in sheaths: keep to a minimum and seal each joint against ingress of materials. Stagger joints in adjacent sheaths by at least 300 mm.
- Protection: keep sheaths free of material detrimental to bond between sheath and grout and, except for material sealing a sheath joint, between sheath and concrete. Seal and protect ends of sheaths and ducts until tendon is threaded through and stressing operations are commenced. Where tendons in sheaths or sheaths alone are left exposed to the atmosphere, use rust inhibitors, in accordance with manufacturer's instructions, to prevent rusting and corrosion of inside of sheaths.
- Duct joints between members comprising precast units stressed together are to be in perfect alignment and joined securely to allow unimpeded cable threading and pulling and to prevent ingress of epoxy mortar used for gluing units together before stressing. Submit details of such joints for approval prior to incorporation in the work.

240 POST-TENSIONING PROCEDURES

- Immediately before tensioning, ensure that all tendons are free to move between jacking points and that members are free to accommodate horizontal and vertical movements due to application of prestress.
- Transfer strength of concrete: unless otherwise specified, do not stress concrete until it has reached the age when two test cylinders taken from it have attained specified transfer strength. Where members consist of jointed elements, the strength at transfer of the jointing material is to be at least equivalent to specified transfer strength of the member.
- Datum point for measuring extension and jack pressure is to be established to the satisfaction of the Engineer.
- Forces and extensions: make allowance to the specified forces where necessary for anchorage friction, wedge pull- in, jack losses and friction due to duct alignment and curvature.
- Stresses in tendons immediately after anchoring are not to exceed 75% of their ultimate tensile strength. During stressing the value is not to exceed 80%.
- Stress tendons at a gradual and steady rate until they attain force and extension specified. Stressing is to be either from one end or both ends as shown on the Drawings.
- Force in tendons is to be obtained from reading on load cell or pressure gauge and extension of tendons is to be measured. Due allowance is to be made for taking up slack in tendons.
- Extension of tendons: if measured extension differs by more than 5% from estimated extension, take corrective action as directed by the Engineer.
- Stressing from one end only: accurately measure pull-in at end remote from jack and make appropriate allowance in measured extension at jacking end.
- Anchoring: when specified force, including any overload of short duration, has been applied to the satisfaction of the Engineer, the tendons are to be anchored. Release jack pressure in a manner to avoid shock to anchorage of tendons.
- At completion of anchoring, if pull-in of tendons is greater than that stipulated by the Engineer, tensioning is to be repeated.
- Cutting tendons: if it is necessary to cut tendons to enable ducts to be grouted, this is to be delayed for as long as possible up to the time of grouting. In all other cases, unless agreed otherwise by the Engineer, do not crop tendons less than 3 days after grouting.
- Records: keep full and detailed records of all tensioning operations including measured extensions, pressure gauge or load cell readings and amount of pull-in at each anchorage. Supply copies of records to the Engineer within 24 hours of each tensioning operation.

242 PRESTRESSING EXECUTION – PRETENSIONING PROCEDURES

- In pretensioned members where tendons are specified as de-bonded from the concrete, they shall be covered with sleeves of PVC or other material approved by the Engineer. The ends of the sleeves shall be taped to the tendon to prevent the ingress of grout.
- Unless otherwise agreed by the Engineer, tendons shall be stressed in accordance with the requirements of this Specifications.
- Members shall be free to accommodate the horizontal and vertical movements due to the application of prestress.
- When the concrete has attained the specified strength, the load shall be transferred gradually without severance of the tendons. The tendons shall then be trimmed back flush to the face of the concrete and specified protection applied to their ends.
- All members shall be indelibly marked to show the specified member mark, the production line on which they were manufactured, the date on which the concrete was cast, the load applied and, if they are of symmetrical section, the face which will be uppermost when the member is in its correct position in the Work. The markings shall be so located that they are not exposed to view when the member is in its permanent position.

250 MIXING AND PLACING GROUT

- Mix grout for a minimum of 2 minutes and until a uniform and colloidal consistency is obtained. Pumpability of grout may be determined to the Engineer's approval in which case efflux time of grout sample immediately after mixing is not to be less than 11 seconds.
- Admixtures containing chlorides or nitrates are not to be used in the grout. Other admixtures may be used with approval of the Engineer and are to be used strictly in accordance with manufacturer's instructions.
- Grout injector is to operate continuously with a sensibly constant pressure up to 0.7 N/mm2 and is to include a system for circulating or agitating the grout while grouting is not in progress. Pump baffles are to be fitted with sieve strainer of 1 mm nominal aperture size to BS ISO 3310-1 and BS ISO 3310-2. Equipment is to be capable of maintaining pressure on completely grouted ducts and is to be fitted with nozzle which can be locked off without loss of pressure in duct.
- Pressure gauges are to be calibrated before first use in the work and thereafter as required by the Engineer.
- Cleaning of equipment, by thoroughly washing with clean water, is to be carried out at least once every 3 hours during grouting operations and at the end of use each day.
- Grouting trials are to be carried out when required by the Engineer.
- Anchorages are to be sealed before grouting.
- Temperatures: do not grout ducts when air temperature in the shade is lower than 3 deg. C. Grout is not to be above 32 deg. C during mixing or pumping and, if necessary, mixing water is to be cooled.
- Cleaning of ducts: clean all ducts thoroughly by compressed air. Fill ducts formed without sheathing with water at least 1 hour before grouting. Do not fill sheathed ducts with water unless required by the Engineer. Blow out water filling to ducts using compressed air.
- Grouting: carry out as soon as practicable after tendons have been stressed and the Engineer's permission to start has been obtained. Completely fill ducts with grout injected in one continuous operation. Allow grout to flow from vents until consistency is equivalent to that being injected. Seal vents consecutively in direction of flow and seal injection tube under pressure until grout has set.
- Protection: protect filled ducts, to the satisfaction of the Engineer, to ensure that they are not subjected to shock or vibration for 1 day and that temperature of grout does not fall below 3 deg. C for 3 days after injection.
- Making good: 2 days after grouting, inspect the level of grout in the injection and vent tubes and make good if necessary.
- Records: keep full and detailed records of grouting including date each duct was grouted, proportion of grout and admixtures used, pressure, details of any interruptions and topping up required. Supply copies of records to the Engineer within 3 days of grouting.
- Testing of ducts: when required by the Engineer, provide facilities and attendance for radiographic testing of ducts.

E20 - FORMWORK FOR IN SITU CONCRETE

To be read with Preliminaries/ General Requirements.

GENERALLY/ PREPARATION

110 LOADINGS

- Requirement: Design and construct formwork to withstand the worst combination of the following:
  - Total weight of formwork, reinforcement and concrete.
  - Construction loads including dynamic effects of placing, compacting and construction traffic.
  - Wind, snow loads, and all possible static and dynamic loads.

111 GENERAL REQUIREMENTS

- Submit to the Engineer full design calculations, detailed drawings, material specification and test certificates for approval.
- Formwork design shall be in accordance with BS 5975 "Code of practice for temporary works procedures and the permissible stress design of falsework".
- Notwithstanding any approval of falsework design by the Engineer, the Contractor will not be relieved of his responsibility for the adequacy and correctness of the design, manufacture and assembly of the falsework.

120 FORMWORK DETAILS

- Provide the following: Formwork shop-drawings including Construction joints - positions and types, Layout of panel joints where exposed to view, Layout of form tie holes where exposed to vie, means of sealing panel joints, form tie holes and at construction joints, Surface of forms, form liners and other means of obtaining required finish.

132 PROPPING

- General: Prevent deflection and damage to the structure. Carry down props to bearings strong enough to provide adequate support throughout concreting operations.
- Method statement: Submit proposals for prop bearings and sequence of propping/ re-propping and back propping.
  - Timing of submission: To be agreed between the permanent works designer and the temporary works coordinator.

141 FORMWORK MATERIALS

- Wood: All timber shall be of sound wood, in good condition and free from defects that might impair its strength. The minimum timber grade, determined in accordance with BS 4978 shall be C16 (SC3).
- Plywood: When plastic coated plywood is used, the Phenol resin on melamine shall be not less than 20% of the total coating weight.
- Steel: Except as otherwise specified or shown on the Drawings, the grades and qualities shall conform to the following applicable standards of ASTM:
  - Structural carbon steel shall conform to ASTM A36/A36M.
  - Structural steel for welding shall conform to ASTM A36/A36M.
  - High-strength low-alloy structural steel shall conform to ASTM A588/A588M.
- Other materials: Other materials, with the approval of the Engineer, may be used for falsework. These include, but not limited to, fibre-glass reinforced plastic, polystyrene, polyethylene, PVC, rubber, concrete, brick etc.

145 PERMANENT FORMWORK

- Location and materials: Submit proposals.

- Standard: Design profiled steel shuttering as permanent formwork in accordance with BS EN 1993-1-3.

170 WORK BELOW GROUND

- Casting vertical faces against faces of excavation: Obtain Consent
- Requirements:Increase width of section to give nominal cover to reinforcement of 75 mm;
  - Prevent contamination of concrete by loose soil;
  - Progressively withdraw face supports as concrete is placed against soil face;
- Submit proposals for maintaining stability of excavated faces and preventing contamination of concrete by loose soil.

190 SUBSTRUCTURE FORMWORK

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.

200 PROPRIETARY UNDERSLAB INSULATION

- Manufacturer: Submit proposals.
  - Product reference: Agrément certified products are available for use underground bearing slabs.
- Recycled content: Submit proposals.
- Thickness:
  - Under slab: 100 mm.
  - To edge of slab: 25 mm.

CONSTRUCTION

310 ACCURACY

- General requirement for formwork: Accurately and robustly constructed to produce finished concrete in the required positions and to the required dimensions.
- Formed surfaces: Free from twist and bow (other than any required cambers).
- Intersections, lines and angles: Square, plumb and true.

311 SHORING AND RESHORING

- General: Comply with applicable Eurocodes, BS 5975, BS EN 12812, and BS EN 12813 for design, installation, and removal of shoring and reshoring.
- Requirements:
  - In multi-storey construction, extend shoring or reshoring over a sufficient number of stories to distribute loads in such a manner that no floor or member will be excessively loaded or will induce tensile stress in concrete members without sufficient steel reinforcement.
  - Plan sequence of removal of shores and reshore to avoid damage to concrete. Locate and provide adequate reshoring to support construction without excessive stress or deflection.

315 SUBSTRUCTURE FORMWORK AND UNDERSLAB INSULATION

- Cutting: Neat and accurate to edges, and around penetrations and down-stands.
- Laying: Tightly butted and fully supported on firm, even substrate.
- Vertical faces: Stiffen as necessary to act as shutter.
- Formwork/ insulation surfaces: Protect from indentation by spacers and other items.
- Joints in formwork/ insulation and with edge structure and penetrations: Seal to prevent penetration of concrete.
- Concrete placement: Restrain formwork/ insulation against movement.

320 JOINTS IN FORMS

- Requirements including joints in form linings and between forms and completed work:

- Prevent loss of grout, using seals where necessary.
- Prevent formation of steps. Secure formwork tight against adjacent concrete.

330 INSERTS, HOLES AND CHASES

- Positions and details:
  - Dimensioned on drawings provided on behalf of the Employer: Do not change without consent.
  - Dimensioned or from other sources: Submit proposals.
- Positioning relative to reinforcement: Give notice of any conflicts well in advance of placing concrete.
- Method of forming: Fix inserts or box out as required. Do not cut hardened concrete without approval.

340 KICKERS

- Method statement: Submit proposals including means of achieving quality of concrete consistent with that specified for the column or wall.
  - Kicker height: As drawing.

350 FORM TIES

- Metal associated with form ties/ devices: Prohibited within cover to reinforcement.
- Compatible with reinforcement metal.

351 PROHIBITION OF FORM TIES

- Do not use ties in the following work: In water resistant concrete construction where form ties can be a source of leakage, and where there are strong objections to the appearance of form tie holes in the finished work.

360 PROPRIETARY FORM TIES FOR WATER RESISTANT CONCRETE

- Tie manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Sealing mortar manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Making good of holes: Fully fill.

361 FORM TIES FOR WATER RESISTANT CONCRETE

- General: Maintain water resistance of construction.
- Tie type and sealing system: Submit proposals.

380 VOID FORMERS

- Manufacturer: Submit proposals.
  - Product reference: expanded plastics (usually polystyrene).

470 RELEASE AGENTS

- Use: All formwork except when fresh concrete relies upon bond to the shutter for its support, ex. for concrete sprayed onto a vertical back shutter and for pavement formwork.
- General: Achieve a clean release of forms without disfiguring the concrete surface.
- Product types: Compatible with formwork materials, specified formed finishes and subsequent applied finishes. Use the same product throughout the entire area of any one finish.
- Protection: Prevent contact with reinforcement, hardened concrete, other materials not part of the form face, and permanent forms.

480 SURFACE RETARDERS

- Use: Obtain approval.
- Reinforcement: Prevent contact with retarder.

481 ACCESSORIES

- Types:
  - Chamfer strips: Wood, metal, PVC, or rubber strips, 20 by 20mm, unless otherwise indicated.
  - Rustication strips: Wood, metal, PVC, or rubber strips, kerfed for ease of form removal.

STRIKING

510 STRIKING FORMWORK

- Timing: Prevent any disturbance, damage or overloading of the permanent structure.

521 MINIMUM PERIOD FOR RETAINING FORMWORK/ TEMPORARY SUPPORTS IN POSITION

- Assumptions: Imposed load will not exceed 10 KN/m² until concrete reaches full strength.
  - Before removing formwork: Submit proposals if assumptions will not be realised.
- Method to be used in assessing early age strength of concrete:
  - Submit proposal;
  - Temperature matched curing (TMC) of cube samples to BS 1881-130 or the different parts of BS EN 12350
  - To BS EN 13670, Annex F.

FORMED FINISHES

600 SAMPLES OF FINISHES AVAILABLE FOR INSPECTION

- Quality of finish: Special finish E20/630.
- Location: as agreed or shown on drawings.
- Variations: None.

605 CONTROL SAMPLES (PART OF THE FINISHED WORK)

- Quality of finish: Special finish E20/630.
- Location: Obtain instructions.
- Area (minimum): 10 m².
- Features to be included: Horizontal and vertical construction joints , horizontal and vertical panel joints, arises, chamfers and margins tie bolts or other fixing devices, pattern of tie holes and filling. Use of the proposed release agent, striking of formwork after an agreed curing period.
- Viewing distance (maximum): 2 m.
- Approval of appearance: Obtain before proceeding with remainder of the work.

610 BASIC FINISH

- Location: refer to drawing.
- Finish: Faces fully compacted and cover to reinforcement provided.

613 ORDINARY FINISH

- Location: Refer to drawing**.**
- Finish: Faces fully compacted. Formed surfaces free from major blemishes and honeycombing. Steps at joints to be less than 5 mm.

615 FINISH TO RECEIVE ASPHALT TANKING OR CHRYSTALLINE/EPOXY COATING

- Finish: Even and suitable to receive waterproofing, and as per manufacturer requirements.
- Permissible deviation of surfaces:
  - Sudden irregularities (maximum): 3 mm
  - Gradual irregularities (maximum): 3 mm, when measured from underside of a 1 m straightedge, placed anywhere on surface.
- Surface blemishes:

  - Permitted: Blowholes less than 10 mm in diameter.
  - Not permitted: Voids, honeycombing, segregation and other large defects.
- Projecting fins: Remove.
- Formwork tie holes: Filled with mortar.

620 PLAIN FINISH

- Location: refer to drawing.
- Finish: Even and dense. Arrange formwork panels in a regular pattern as a feature of the surface.
- Permissible deviation of surfaces:
  - Sudden irregularities (maximum): 3 mm.
  - Gradual irregularities (maximum): 3 mm, when measured from the underside of a 1 m straightedge, placed anywhere on surface.
- Variations in colour:
  - Permitted: Those caused by impermeable formwork linings.
  - Not permitted: Those caused by contamination or grout leakage.
- Surface blemishes:
  - Permitted: Blowholes less than 10 mm in diameter and at an agreed frequency.
  - Not permitted: Voids, honeycombing, segregation and other large defects.
- Formwork tie holes: In a regular pattern and filled with matching mortar.

630 SPECIAL FINISH

- Location: refer to drawings.
- Finish: Smooth and even. Formwork panels as large as practicable. Arrange in a regular pattern as a feature of the surface.
  - Special requirements: None.
- Permissible deviation of surfaces:
  - Sudden irregularities (maximum): 3 mm.
  - Gradual irregularities (maximum): 3 mm, when measured from the underside of a 1 m straightedge, placed anywhere on surface.
- Variations in colour:
  - Permitted: Those caused by impermeable formwork linings.
  - Not permitted: Those caused by contamination, grout leakage and replacement of formwork panels.
- Cover spacers: Submit proposals.
- Surface blemishes:
  - Permitted: Blowholes less than 5 mm in diameter and at an agreed frequency.
  - Not permitted: Voids, honeycombing, segregation and other defects.
- Formwork tie holes: In a regular pattern and filled with matching mortar.

640 ROUGH BOARD FINISH

- Forms or form linings: Rough textured softwood boards with smooth planned joint faces.
  - Width of boards: 100 mm.
  - Moisture content at time of casting: 18-25 %.
- Arrangement of boards: Vary textures to give uniform overall effect.
  - Orientation of boards: Horizontal, Vertical, as shown on drawings.
  - End joints: Not permitted.
  - Nail heads: Flush with surface.
- Surface blemishes: Penetration of grout between boards not permitted. Wet pre-assembled forms with clean water before erecting and keep damp until concrete is placed.
- Formwork tie holes: In a regular pattern and filled with matching mortar.

650 RIBBED FINISH

- Forms or form linings: Splayed timber battens secured to plywood backing.
  - Finished size of battens: 40 mm x 30 mm.
  - Centres of battens: 50 mm.
  - Fixing to plywood backing: Adhesive and screws.
  - Finish: Smooth with clean, sharp arises at junctions with backing. Prevent penetration of grout behind battens.
- Cover spacers: Submit proposals.
- Surface blemishes:
  - Permitted: Blowholes less than 5 mm in diameter and at an agreed frequency.
  - Not permitted: Voids, honeycombing, segregation and other defects.
- Formwork tie holes: In a regular pattern and filled with matching mortar.

660 PROPRIETARY FORM LINING FINISH

- Form linings:
  - Manufacturer: submit proposal.
    Product reference: moulded expanded polystyrene, flexible urethanes, plasticized PVC, synthetic or natural rubber, pressed steel sheet, papier Marché.
- Installation of linings: Securely to support formwork and jointed neatly.

All types of spacer will to some extent be visible on the concrete face. Spacers with flat contact faces will be clearly visible and will be unsightly. The problem may be reduced by using Spacers with recessed contact faces, Plastic wheel spacers with nibs, provided that the colour is similar to that of the concrete, or Spacers made with the same materials and mix proportions as the bulk of the concrete

- Cover spacers: Submit proposal.
- Surface blemishes:
  - Permitted: Blowholes less than 5 mm in diameter and at an agreed frequency.
  - Not permitted: Voids, honeycombing, segregation and other defects.
  - Formwork tie holes: In a regular pattern and filled with matching mortar.

665 CONTROLLED PERMEABILITY FORM LINING FINISH

- Form linings:
  - Manufacturer: Submit proposals.
    Product reference: CIRIA report C511, section 6.
- Installation of linings: As part of a controlled permeability formwork (CPF) system. Prevent any restrictions to drainage of water.
- Cover spacers: Submit proposals.
- Surface blemishes:
  - Permitted: Blowholes less than 5 mm in diameter and at an agreed frequency.
  - Not permitted: Voids, honeycombing, segregation and other defects.
- Formwork tie holes: Regular pattern and filled with matching mortar.

700 FINISH FOR ABRASIVE BLASTING

- Finish: Even with accurate, true and even joints.
- Permissible deviation of surfaces:
  - Gradual irregularities when measured from the underside of a 1 m straightedge, placed anywhere on surface (maximum): 3 mm.
- Cover spacers: Submit proposal.
- Surface blemishes:
  - Permitted: Blowholes less than 10 mm in diameter and at an agreed frequency.
  - Not permitted: Voids, honeycombing, segregation and other large defects.
- Formwork tie holes: In a regular pattern and filled with matching mortar.

710 FINISH FOR TOOLING

- Finish: Even with accurate, true and even joints.
- Permissible deviation of surfaces:
  - Gradual irregularities when measured from the underside of a 1 m straightedge, placed anywhere on surface (maximum): 5 mm.
- Cover spacers: Submit proposal.
- Surface blemishes:
  - Permitted: Blowholes less than 10 mm in diameter and at an agreed frequency.
  - Not permitted: Voids, honeycombing, segregation and other large defects.
- Formwork tie holes: In a regular pattern and filled with matching mortar.

750 ARRISES, MARGINS AND JUNCTIONS

- Requirements:
  - As shown on drawings.

760 REPAIRING FORMED SURFACES

- General: Surface defects include colour and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins or other projections on the surface, stains and other discolorations that cannot be removed by cleaning.
  - Repair and patch defective areas when approved by Engineer.
  - Remove and replace concrete that cannot be repaired and patched to Engineer's approval.
  - Any remedial treatment to surfaces shall be agreed with the Engineer following inspection, immediately after removing the formwork, and shall be carried out without delay. Any concrete surface which has been treated before being inspected by the Engineer, shall be liable to rejection.
- In case of noncompliance:
  - Concrete not meeting the specified requirements shall be removed and rebuilt without delay unless the Engineer approves that a repair may be satisfactorily effected. This agreement shall not preclude the subsequent rejection of the repaired Work by the Engineer.
  - All repairs shall be performed by qualified technicians/personnel to guarantee the required Work.
  - Any repair method submitted for approval shall produce a result that is impermeable as the original concrete.
  - Subsequent tests on the repaired concrete shall be carried out at the discretion of the Engineer in order to establish the quality of the repair, particularly at the joint between the original and repaired concrete.

E30 - REINFORCEMENT FOR IN SITU CONCRETE

To be read with Preliminaries/ General Requirements.

REINFORCEMENT

110 QUALITY ASSURANCE OF REINFORCEMENT

- Standards:
  - Reinforcement: To BS 4449, BS 4482, BS 4483, BS 6744 or BS EN 10080.
  - Cutting and bending: To BS 8666, BS EN 1992-1-1, and BS EN ISO 3766.
- Source of reinforcement: Companies holding valid certificates of approval for product conformity issued by the UK Certification Authority for Reinforcing Steels (CARES) or international equivalent certification.

150 RIBBED BAR REINFORCEMENT

- Standard: To BS 4449 or BS EN 10080.
  - Strength grade: B500B.

155 HIGH TENSILE STEEL WIRE AND STRAND FOR THE PRESTRESSING OF CONCRETE

- Standard: to BS EN ISO 16120-4. BS EN 10020, Non-alloy steel wire rod for conversion to wire – Part 1: General requirements.
- Steel wire: Steel wire shall comply with BS 5896.
- Pre-tensioning strand: BS 5896, low relaxation strand.
- Post-tensioning strand: BS 5896, Grade 270, uncoated, 7-wire, low relaxation strand.
- Post-tensioning bars: BS 5896, uncoated high-strength steel bar.
- Anchorages: to be cast type, to BS EN 13391 or other approved standard.

160 GALVANIZED STEEL REINFORCEMENT

- Galvanizing: To BS EN ISO 1461 after cutting but before bending.

210 STANDARD FABRIC REINFORCEMENT

- Standard: To BS 4483 and BS 8666.
- Strength grade: B500B.

211 WELDED FABRIC REINFORCEMENT

- Standard: To BS 4482 and BS 8666.
- Strength grade: B500B.260 PROPRIETARY MECHANICAL COUPLERS
- Locations: As shown on Drawings
- Strength: Capable to resist the tensile strength of the connected bars.
- Manufacturer: Submit proposals.
  - Product reference: CARES or international equivalent certification.

266 REINFORCEMENT ACCESSORIES

- Joint dowel bar: plain dowel bar with lubrication or debonding compound as per clause E40/437 on one half of dowel length to prevent concrete bonding to one side of joint. Cut bars true to length with end square and free of burs.
- Bar supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire fabric in place. Manufacture bar supports from plastic, precast concrete or fiber reinforced concrete of greater compressive strength than concrete.

WORKMANSHIP

310 CUTTING AND BENDING REINFORCEMENT

- General: To schedules and to BS 8666, BS EN 10080, BS EN ISO 3766.
- Bending on site, including minor adjustments: Obtain instructions
- Continuity reinforcement: As shown on drawing.

320 PROTECTION OF REINFORCEMENT

- Prevent Dropping from height, mechanical damage and shock loading.
- Cleanliness of reinforcement at time of pouring concrete: Free from corrosive pitting, loose mill scale, loose rust and contaminants which may adversely affect the reinforcement, concrete, or bond between the two.

410 LAPS OR SPLICES

- For Details not shown on drawings: Obtain instructions
- For tension piles, staggered mechanical couplers distant of at least 800mm should be used to splice reinforcement**.**

427 LAPS IN FABRIC REINFORCEMENT

- Terms: As defined in BCA publication 97.321.
- Lap type:
  - Long edge of fabric: Butt end bars in adjacent fabric sheets and provide loose bars of the same diameter and type as the fabric bars, tied to and with a full lap with the bars in each sheet.
  - Short edge of fabric: Butt end bars in adjacent fabric sheets and provide loose bars of the same diameter and type as the fabric bars, tied to and with a full lap with the bars in each sheet.
- Other requirements: Stagger end laps and Stagger laps in fabric to each face and locate laps away from cut joints in ground slabs.

430 WELDING REINFORCEMENT

- Standard: BS EN 10080, BS EN ISO 17660-1 & 2.
- Joint type/ dimensions: Submit proposals.
  - Location: Submit proposals, showing joints in principal tension reinforcement staggered.
- Site welding: Not permitted.

451 FIXING REINFORCEMENT

- Standard: To BS 7973-1 and -2.
- Installation: In addition to any spacers and chairs shown on drawings or schedules, provide adequate support, tie securely and maintain the specified cover.
- Tying:
  - Wire type: 16 gauge black annealed. Use stainless steel wire for stainless steel reinforcement.
  - Ends of tying wire: Prevent intrusion into the concrete cover. Remove loose ends.
- Compatibility of metals: Prevent contact between ordinary carbon steel and stainless or galvanized reinforcement.
- Electrical continuity: All steel reinforcement bars should ensure the electrical continuity of the steel reinforcement bars with an overall resistance not exceeding 0.2 Ohm.

454 FIXING REINFORCEMENT FOR SPRAYING CONCRETE

- First reinforcement layer: Install prior to concreting, with chairs or other means of support fixed ready for installation of subsequent reinforcement layer.
- Subsequent reinforcement layer: Fabricate as a mat prior to concreting. Install when first reinforcement layer is fully encapsulated in concrete.

470 TOLERANCES ON COVER

- Tolerance (maximum): 5 mm.
- Checking specified cover dimensions: Before concreting check that cover dimensions will be achieved.

480 NOMINAL COVER TO REINFORCEMENT

- Nominal cover: refer to general notes drawings.

510 RUST STAINING

- Prevent Staining of surfaces of concrete which will be exposed to view in the finished work.

520 COVER METER SURVEY

- Purpose of survey: To check positions of reinforcement and that the specified cover has been achieved.
- Type of cover meter: A magnetic induction digital display type selected to suit arrangement and type of reinforcement.
  - Use: In accordance with recommendations of BS 1881-204 and manufacturer as appropriate to yield accurate results.
  - Surveyor: Experienced with cover meter surveys.
  - Calibration: At the outset and thereafter regularly at 45 minute (maximum) intervals.
- Locations for checking: at doubted locations, and as required by the Engineer. Include columns, beams, cantilevers, slab soffits and all faces exposed to the weather in the finished structure.
- Timing: As soon as practicable after casting.
  - Notification: Give adequate notice.
- Results: Submit. Notify immediately where specified cover has not been achieved.

521 COVER METER FOR USE BY OTHERS

- Type of cover meter: Provide a magnetic induction digital display type selected to suit arrangement and type of reinforcement.
- Availability: Calibrate and maintain ready for use by others as instructed.
  - Periods/ time**:** Within 24 hours of striking formwork.

E40 - DESIGNED JOINTS IN IN SITU CONCRETE

To be read with Preliminaries/General Requirements.

120 CONSTRUCTION/ MOVEMENT JOINTS GENERALLY

- Accuracy: Position and form joints accurately, straight, well-aligned and truly vertical or horizontal or parallel with setting out lines of the building.
- Modifications to joint design or location: Submit proposals.
- Placing concrete to form movement joints:
  - Maintain effectiveness of joints. Prevent concrete entering joints or penetrating or impregnating compressible joint fillers.
  - Do not place concrete simultaneously on both sides of movement joints.

132 ADDITIONAL REQUIREMENTS FOR CONSTRUCTION JOINTS

- Limitations: Permitted subject to restrictions in section E10 and engineer's approval.

210 FORMED JOINTS

- Forms/ stop ends generally: Rigid and grout-tight.
- Forms/ stop ends for projecting continuity reinforcement: To accommodate bars or fabric without temporary bending or displacement.

211 FORMED JOINTS IN CONCRETE WEARING SURFACES

- Temporary forms: Square edged with a steel top surface.
- Placing concrete: Compact thoroughly at edges to give level, closely abutted joints with no lipping.

220 PRECAST CONCRETE PERMANENT SIDE FORMS

- Manufacturer: submit proposal.
  - Product reference: Submit proposal
- Depth: depending on the depth of precast element.
- Installation: To accurate line and level with concrete thoroughly compacted at edges and with no lipping.

225 PREFABRICATED STEEL PERMANENT JOINT FORMERS

- Manufacturer: Submit proposals.
  - Product reference: Submit proposal Depth: depending on the depth of precast element.
- Installation: To accurate line and level with concrete thoroughly compacted at edges and with no lipping.

230 PREPARATION OF CONSTRUCTION JOINTS

- Roughening of joint surfaces:
  - Brushing and spraying: Remove surface laitance and expose aggregate finish while concrete is still green.
  - Other methods: Submit proposals.
- Condition of joint surfaces immediately before placing fresh concrete: Clean and damp.

260 SAWN CRACK INDUCING GROOVES

- Groove dimensions:
  - Depth**:** As shown on drawings
  - Width: As narrow as practicable.
- Sawing: Sufficiently early to prevent random cracking within 24 hours of casting slab and to produce strong, well defined arrises.

- Groove filling: Sealant or Sheet joint filler and sealant, noting that filling should be left as late in the construction process as possible.

310 FLEXIBLE WATERSTOPS

- Manufacturer: Submit proposals.
  - Product reference: Self-sealing hydrophilic rubber-based water-stops. Sandwiched centrally in the joint, they swell on contact with penetrating water to form a tight compression seal.
  - Injection hose systems: A perforated PVC hose is encased in polyurethane foam into which a polyurethane-based resin is injected after most of the drying shrinkage has taken place in the concrete.
- Junctions and angles: Use factory formed junction pieces.
- Placing concrete: Fully compact concrete around water-stops with no voids or porous areas.

320 HYDROPHILIC WATERSTOPS

- Manufacturer: Submit proposals.
  - Product reference: Submit Proposal
- Location: Fixed to first cast concrete surface 80 mm (minimum) clear from face of structure.
- Method of fixing: Bonded using an adhesive approved by water-stop manufacturer or Nailed.
- Condition of concrete surface at time of fixing: Clean and free from ponded or running water.
- Protection: Prevent wetting of exposed sections of water-stop.

410 CARBON STEEL TIE BARS

- Standard: To BS 4449.
  - Product form: Ribbed.
  - Strength grade: B500B.
- Cleanliness: Free from corrosive pitting, loose mill scale, loose rust and contaminants which may adversely affect the tie bars, reinforcement, concrete, or bond between the two.
- Position: Centred on joint.
- Other requirements: None.

415 STAINLESS STEEL TIE BARS

- Standard: To BS 6744.
  - Product form: Ribbed.
  - Designation: 1.4162.
  - Strength grade: 500.
- Cleanliness: Free from contaminants which may adversely affect the tie bars, concrete, or bond between the two.
- Position: Centred on joint.

420 FABRIC TIE STRIPS

- Standard: To BS 4483.
- Cleanliness: Free from corrosive pitting, loose mill scale, loose rust and contaminants which may adversely affect the fabric, concrete, or bond between the two.
- Position: Width of the mesh strip centred on the joint.

435 STAINLESS STEEL DOWEL BARS

- Standard: To BS 6744.
  - Designation: 1.4362.
  - Product form: Plain.
  - Strength grade: 200.
  - Properties: Perfectly straight, with sawn (not sheared) ends.

- De-bonding: Achieve effective de-bonding of each bar
  - Material: Suitable proprietary de-bonding compound or Flexible polymeric coating as Highways Agency 'Specification for Highway Works' clause 1011(7)
  - Extent: Half-length of bar.
- Position: At right angles to and centred on joint.
- Other requirements: Fit de-bonded ends of bars in expansion joints with an approved type of cap incorporating not less than 30 mm of compressible material.

437 DEBONDING COMPOUND

- Manufacturer: submit proposal.
  - Product reference: The compound should be a Flexible polymeric coating as Highways Agency 'Specification for Highway Works'.

440 LOAD TRANSFER SYSTEMS

- Manufacturer: Submit proposals
  - Product reference: for proprietary load transfer systems other than reinforcement or dowel bars

510 SHEET MEMBRANE FOR SLIDING JOINTS

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Fixing: Bond to first cast concrete surface, or otherwise hold in position during concreting.

520 SHEET JOINT FILLER FOR EXPANSION JOINTS, FOR ISOLATION JOINTS

- General: The joint filler material should be robust and resilient. It should be capable of accommodating anticipated movements without unacceptable deformation, and minimizing the transfer of loads across joints when required. The joint filler material should also be compatible with any joint sealant with which it will come into contact.
- Manufacturer: Submit proposals.
  - Product reference: The exposed edges of joint fillers are normally protected by sealants.
- Joints finished with sealant: Leave sufficient space for sealant by using temporary formers.

521 BONDING AGENT

- Standard: ASTM C1059/C1059M, Type II, non-redispersible, acrylic emulsion or styrene butadiene.
- For bonding hardened or freshly mixed concrete to hardened concrete.

545 COMPRESSIBLE SEALING STRIP SYSTEM FOR SAWN JOINTS IN FLOOR SLABS, FOR EXPANSION JOINTS

- Manufacturer: Submit proposals.
  - Product reference: matching with joint filler and having a fire resistance similar to substrate element.
  - Colour: not applicable.

590 INSPECTION OF TIED AND PARTIALLY TIED JOINTS

- Purpose: To determine whether shrinkage is concentrated at occasional joints
- Timing: At intervals from one month after casting of slab for duration of works.
- Joints that have opened significantly more than the average: Submit proposals for grouting.

E41 - WORKED FINISHES TO IN SITU CONCRETE

To be read with the structural drawings and structural basis of design report.

140 SAMPLES AVAILABLE FOR INSPECTION

- Type: Tooled finish as clause 430.

145 CONTROL SAMPLES

- Sample areas that are part of finished work: To be agreed.
- Location: To be agreed.
- Approval of appearance: Obtain before proceeding with remainder of the work.

150 FINISHING

- Timing: Carry out at optimum times in relation to setting and hardening of concrete.
- Prohibited treatments to concrete surfaces:
  - Wetting to assist surface working.
  - Sprinkling cement.

210 TAMPED FINISH

- Surface on completion: Even array of parallel ribs**.**

220 SCORED FINISH

- Surface on completion: Roughened, regular pattern.
  - Scoring tool: Metal comb.

230 BRUSHED FINISH

- Surface on completion: Light even texture.

240 WOOD FLOATED FINISH

- Surface on completion: Slightly coarse, even texture with no ridges or steps.

310 SMOOTH FLOATED FINISH

- Surface on completion: Even with no ridges or steps.

320 TROWELLED FINISH

- Surface on completion: Uniform, smooth but not polished, free from trowel marks and blemishes and suitable to receive specified flooring material.

330 TROWELLED FINISH FOR WEARING SURFACES

- Surface on completion: Uniform and smooth, free from trowel marks and blemishes.

335 DRY SHAKE TROWELLED FINISH FOR WEARING SURFACES

- Dry shake manufacturer: submit proposal.
  - Product reference: submit proposal.
  - Mix: Manufacturer's standard.
  - Application: Sprinkle evenly at appropriate stages during floating and before trowelling.
    Application rate: as per approved manufacturer.
- Curing agent/ Sealer: Manufacturer as dry shake apply immediately after completion of trowelling.
- Protection: Prevent marking of adjacent surfaces.
- Surface on completion: Uniform and smooth, free from trowel marks and blemishes.

340 DEWATERED TROWELLED FINISH FOR WEARING SURFACES

- Dewatering:

  - Timing: Immediately after compacting concrete.
  - Removing water: Use vacuum process.
- Surface on completion: Uniform and smooth, free from trowel marks and blemishes.

410 POWER GROUND FINISH FOR WEARING SURFACES

- Grinding: Remove 1-2 mm from surface.
  - Timing: When concrete is sufficiently hard for fine aggregate surface particles not to be dislodged.
- Cleaning: Remove dust and wash down.
- Surface on completion: Even glass-paper texture, free from blemishes and trowel marks.

510 SURFACE HARDENER

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Condition of substrate prior to application: Cured, clean and free from surface contaminants.
- Application: Evenly to dry surfaces. After absorption, wash surface immediately with clean water.
  - Additional applications: As manufacturer's recommendations.
- Solutions and wash water: Do not discharge to drains. Store and dispose of safely.

520 SURFACE SEALER

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals. Check suitability with sealer manufacturers.
- Substrate:
  - Moisture content: As recommended by sealer manufacturer. Test relative humidity to BS 8203, Annex A where required to verify suitability.
  - Condition prior to application: Cured, clean and free from contaminants.
- Primer: Primer as recommended by Manufacturer.
- Application: Evenly to dry surfaces to form an effective seal but without a glossy finish.

530 SLIP RESISTANCE TESTING OF WEARING SURFACES

- Test: To BS 7976-2 using a Transport Research Laboratory (TRL) Pendulum.
  - Timing: Give adequate notice.
  - Test results: Submit, inclusive of slip resistance values (pendulum test value [PTV]), in the wet and dry states.

E42 - ACCESSORIES CAST INTO IN SITU CONCRETE

To be read with the structural drawings and structural basis of design report.

GENERAL

110 ACCESSORIES SPECIFIED ELSEWHERE

- Item/ location: as shown on drawings.

PRODUCTS

310 HOLDING DOWN SYSTEMS

- Bolts: see drawing.
  - Material: Carbon steel.
  - Standard: To BS 7419
  - Type: see drawing.
  - Property class to [BS EN ISO 898-1]: 4.6.
  - Thread diameter: see drawing.
  - Coating: galvanized.
- Nuts:
  - Standard: To BS EN ISO 4032.
  - Material: Carbon steel.
  - Class: To suit NSSS CE Marking version, clause 2.4.5 and Table 2.6.
  - Coating: galvanized
- Washers:
  - Standard: To BS EN ISO 7091.
  - Material: see drawing.
  - Class: To suit NSSS CE Marking version, clause 2.4.5 and Table 2.6.
  - Coating: galvanized.
- Bolt box: None, hole formed around bolt using polystyrene former.
- Anchorage: see drawing.
- Other requirements: see drawing.

320 CAST-IN SOCKETS see drawing

- Material: Stainless steel].
  - Coating or treatment: galvanized.
- Manufacturer: Submit proposals.
  - Product reference: see drawing.
- Cleanliness: Plug inside as necessary to prevent ingress of grout during concreting.
- Safe working load (minimum): see drawing.
- Temporary fixings to shutter/ temporary supports: Bolts through shutter.

330 ANCHOR BOLTS

- Material: galvanized steel (internal), Stainless steel (external).
  - Designation: see drawing.
  - Coating or treatment: galvanized.
- Manufacturer: submit proposals.
  - Product reference: submit proposals.

335 SHEAR LOAD CONNECTORS

- Material: as shown on drawings.

  - Designation: as shown on drawings.
- Manufacturer: Submit proposals.
  - Product reference: submit proposal.
- Anchors: Welded to back of section.
  - Type/ centres: submit proposals.
- Temporary fixings to shutter/ temporary supports: stainless steel nails.

340 CHANNELS AND SLOTS

- Material: galvanized steel (internal), Stainless steel (external).
  - Designation: see drawing.
  - Coating or treatment: galvanized.
- Manufacturer: Submit proposals.
  - Product reference: submit proposals.
- Anchors: Welded to back of section.
  - Type/ centres: submit proposals.
- Temporary fixings to shutter/ temporary supports: galvanized carbon steel nails or staplesor Stainless-steel nails or staples.
- Bolts/ ties: see drawing.
- Other requirements: see drawing.

345 ANCHOR PLATES/ COLUMN SHOES

- Location: see drawing.
- Material: galvanized steel or Stainless steel
  - Designation: see drawing.
- Manufacturer: Submit proposals.
  - Product reference: submit proposals.
- Anchors: Welded to face in contact with concrete.
  - Type/ centres: see drawing.
- Temporary fixings to shutter: galvanized carbon steel nails or staples or Stainless steel nails or staples or Self drilling and tapping screws through shutter into plate or Set screws through shutter into tapped holes in plate].

350 PROPRIETARY CORNER GUARDS

- Location: to exposed corners of columns.
- Material: galvanized steel or Stainless steel
  - Coating or treatment: Galvanized.
- Manufacturer: Submit proposals.
  - Product reference: submit proposals.
- Anchors: Welded to face in contact with concrete.
  - Type/ centres: submit proposals.
- Temporary fixings to shutter: galvanized carbon steel nails or staples or Stainless-steel nails or staples or Self drilling and tapping screws through shutter into guard or Set screws through shutter into tapped holes in each leg of guard.

360 CORNER GUARDS

- Location: to exposed corners of columns.
- Material: galvanized steel or Stainless steel.
  - Designation: see drawing.
  - Coating or treatment: Galvanized.
- Section: Cold formed angle.

  - Size: see drawing.
- Anchors: Welded to face in contact with concrete.
  - Type/ centres: see drawing.
- Temporary fixings to shutter: galvanized carbon steel nails or Stainless steel staples or Self drilling and tapping screws through shutter into guard or Set screws through shutter into tapped holes in each leg of guard.

370 FABRICATED EDGE STRIPS AND FRAMES

- Use: for chequer plate duct covers and for open grid flooring.
- Material: Carbon Steel or Stainless Steel as for chequer plate.
  - Designation: see drawing.
  - Coating or treatment: galvanized.
- Section: see drawing.
- Anchors: Welded to face in contact with concrete.
  - Type/ centres: see drawing.
- Temporary fixings to shutter/ temporary support: galvanized carbon steel nails or Stainless steel nails or Self drilling and tapping screws through shutter or temporary support into frame or Set screws through shutter or temporary support into tapped holes in frame.

380 DUCTS through slabs, through trench fill foundations

- Material Concrete to BS EN 1916.
- Shape: see drawing.
  - Size: see drawing.
- Location: submit location for approval.
- Other requirements: Ducts to be set perpendicularly to face of concrete unless otherwise indicated.

390 GALVANIZED COATINGS

- Standard: to BS 7371-6 and BS EN ISO 1461.
  - Galvanizing: Applied and passivated by component manufacturer. Threaded items tapped after galvanizing.

395 SHERARDIZED COATINGS ON METAL FASTENERS

- Standard: To BS 7371-8.

EXECUTION

610 HOLLOW ACCESSORIES

- Filling/ sealing: Temporally fill or seal accessory to prevent ingress of grout during concreting. Leave filling/ seals in position until accessory is used.

620 TEMPORARY SUPPORTS

- Location: Provide to hold accessories for casting into un-shuttered surface of concrete, set at a level that will not adversely affect finish of concrete surface remote from accessory.
- Position: Hold securely to prevent lateral movement or rotation of accessory during concreting.

630 PROTECTIVE COATINGS

- Inspect: Immediately prior to casting concrete.
- Damage to coatings:
  - Minor: Submit proposals for coating repair**.**
  - Significant: Replace accessory.

640 INSTALLATION

- Cleanliness: At time of casting, surfaces in contact with concrete to be free from contaminants which may adversely affect accessory, reinforcement, concrete, or bond between accessory and concrete
- Position: Hold accessory firmly in position, preventing displacement during concreting.
- Other requirements: see drawing, check with engineer on site.

E60 PRECAST/ COMPOSITE CONCRETE FLOORS/ ROOF DECKS

To be read with Preliminaries/ General Requirements.

PROPRIETARY FLOORS/ ROOF DECKS

100 GENERALLY

- Contractor is to submit the following:
  - Design Mixes: For each concrete mixture. Include compressive strength and, if required, water-absorption tests.
  - Shop Drawings: Detail fabrication and installation of precast structural concrete units. Indicate member locations, plans, elevations, dimensions, shapes, cross sections, openings, and types of reinforcement, including special reinforcement.
    - Include member locations, plans, elevations, dimensions, shapes and sections, openings, support conditions, and types of reinforcement, including special reinforcement.
    - Detail fabrication and installation of precast structural concrete units, including connections at member ends and to adjoining construction.
    - Indicate joints, reveals, drips, chamfers, and extent and location of each surface finish.
    - Indicate separate face and backup mixture locations and thicknesses.
    - Indicate type, size, and length of welded connections by BS EN ISO 2553 standard symbols.
    - Detail loose and cast-in hardware, lifting and erection inserts, connections, and joints.
    - Indicate locations, tolerances, and details of anchorage devices to be embedded in or attached to structure or other construction.
    - Indicate and locate openings larger than 250 mm. Where additional structural support is required, include header design.
    - Indicate location of each precast structural concrete unit by same identification mark placed on panel.
    - Indicate relationship of precast structural concrete units to adjacent materials.
    - Indicate locations, dimensions, and details of thin-brick units, including corner units and special shapes, and joint treatment.
    - Indicate locations, dimensions, and details of stone facings, anchors, and joint widths.
    - Indicate estimated camber for precast floor slabs with concrete toppings.
    - Indicate shim sizes and grouting sequence.
    - If design modifications are proposed to meet performance requirements and field conditions, submit design calculations and Shop Drawings. Do not adversely affect the appearance, durability, or strength of units when modifying details or materials and maintain the general design concept.
  - Delegated-design submittals: For precast structural concrete indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified Engineer responsible for their preparation.
    - Show precast structural concrete unit types, connections, types of reinforcement, including special reinforcement, and concrete cover on reinforcement. Indicate location, type, magnitude, and direction of loads imposed on the building structural frame from precast structural concrete.
  - Sample of bearing pads.

140 PRECAST FLOOR PLATE FOR COMPOSITE FLOOR (Hollow Core Slab).

- Manufacturer: Submit proposals.
  - Product reference: As per drawings.

- Finish:
  - Top surface: Rough to improve bonding with concrete topping.
- In situ continuity reinforcement: As per drawings.

GENERAL/ PERFORMANCE

240 DETAILING OF PROPRIETARY SYSTEM
- Installation details: Submit location and assembly drawings showing every aspect of the construction, incorporated components and features, trimming for voids, holes for services, and related work by others.
  - Purpose: To allow checking of compatibility with surrounding structure and coordination of services.
- Method statement and risk assessment for installation: Submit.
- Programme: Submit well in advance of construction.

250 CONTRACTOR'S STRUCTURAL DESIGN
- Design: Complete in accordance with the designated code of practice to satisfy specified performance criteria.
  - Composite construction: As per drawings providing partial continuity to control cracking and, where required, diaphragm and tie action.
  - Fully precast construction: As per drawings providing diaphragm and tie action where required.

INSTALLATION

320 CONCRETE INFILL
- Designated concrete: To BS 8500-2.
  - Designation: As per drawings.
  - Aggregate size (maximum): 10 mm generally but 6 mm in shear keys between precast units.
- Preparation: Thoroughly clean and wet surfaces of precast units.
- Placing: Avoid segregation and compact thoroughly to eliminate voids.
  - Extent: Fill troughs and other holes.
  - Finish: Flush with top of precast units.
- Protection: Prevent movement of units until concrete has gained sufficient strength.

325 GROUTING
- Preparation: Thoroughly clean and wet surfaces.
- Fill all joints and surface irregularities.

330 EXPANDED POLYSTYRENE VOID FORMERS
- Expanded polystyrene: To BS EN 13163.
- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Compressive strength (minimum): As per drawings.
- Size: As per drawings.

345 IN SITU CONCRETE TOPPING TO HOLLOW CORE SLABS.
- Concrete: As section E10.
  - Thickness (minimum): 75mm.
- Formwork: As section E20.
- Reinforcement: As section E30.
  - Cover: As per drawings

- Construction/ Movement joints: As section E40.
- Finish: Trowelled as per section E41.
  - Surface regularity: As section E05, suitable for specified floor finish.

350 LEVELS OF STRUCTURAL CONCRETE FLOORS

- Tolerances: See Preliminaries and General Requirements.

F10 BRICK/ BLOCK WALLING

To be read with Preliminaries/ General Conditions.

TYPES OF WALLING

355A CONCRETE COMMON BLOCKWORK IN PARTITIONS AND WHERE INDICATED

- Blocks: To BS EN 771-3.
  - Manufacturer: To be approved.
    Product reference: to be approved.
  - Configuration: Group 2- Greater than 25% and less than or equal to 60% formed vertical voids.
  - Compressive strength- Net area individual unit Compressive Strength: minimum 10 MPa for non- load bearing walls.
  - Net area individual unit Compressive Strength: minimum 15 MPa for load bearing walls.
  - Net area individual unit compressive strength: minimum 7 MPa for non-load bearing interior partitions.
  - Freeze/ Thaw resistance: Not to be left exposed.
  - Thermal properties: U-value for external wall complete assembly with insulation not more than 0.4 w/m2. k.
  - Recycled content: 0% (minimum) to BS EN ISO 14021.
  - Work sizes (length x width x height): as indicated on drawings and as approved by Engineer.
    Tolerance category: D1.
  - Special shapes: As shown on drawings.
  - For load bearing CMU walls: normal weight, with oven dry concrete density not less than of 2000 kg/cu.m.
  - For non-load bearing CMU walls: medium weight, with oven dry concrete density not less than of 1850 kg/cu.m.
  - Reaction to Fire: Class A1.

- Typical fire-rating based on equivalent thickness method for concrete masonry units including cement plaster facings on both sides with thickness not less than 15mm for each facing:
  - 100mm solid: 2hrs.
  - 100mm hollow with fill percentage not less than of 55%: 1 Hr.
  - 150mm solid: 4 Hrs.
  - 150mm hollow with fill percentage not less than 53%: 2 Hrs.
  - 200mm solid: 4 Hrs.
  - 200mm hollow with fill percentage not less than 45%: 2.25 Hrs.

- Mortar: As section Z21.
  - Standard: To BS EN 998-2.
  - Mix: 1:3 masonry cement: sand.
  - Additional requirements: Bond strength: not less than 14 N/mm².
- Bond: Half lap stretcher.

TESTING

410 COMPRESSIVE STRENGTH OF MORTAR FOR EACH WALLING TYPE

- Testing authority: An approved laboratory.
- Test method: To BS EN 1015-11.
- Preliminary tests procedure: As follows:
  - Specimens:

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Number of specimens: 6.
Type : 40 x 40 x 160 mm prism.
Preparation: At least six weeks before walling commences.

- Specimen testing: Half of specimens at 7 days. Remainder at 28 days.
  Retarded mixes: Extend curing periods to include retardation period.
- Response to result: If mean compressive strength at 28 days is not within the range given below repeat tests with more suitable sand or next higher mortar class.

- Site tests procedure: As follows.
  - Number of specimens: Six per 150m² of walling or per storey whichever the more frequent.
  - Specimen types: As preliminary test but prepared during construction.
  - Specimen testing: Half of specimens at 7 days. Remainder at 28 days.
    Retarded mixes: Extend curing periods to include retardation period.
- Required test mean compressive strength at 28 days (N/mm²): To be within the following range:
  - Walling type: Concrete Blockwork.
    Preliminary tests minimum (N/mm²): 14.0.
    Preliminary tests maximum (N/mm²): No Value.
    Site tests minimum (N/mm²): 14.0.
    Site tests maximum (N/mm²): No Value.
- Results: Submit.

415 FRESH MORTAR CEMENT CONTENT

- Test method: BREMORTEST in accordance with Building Research Establishment Information Paper 8/89.
- Test specimens: Test mortar for the following wall types: F10/ 355A and all other types of walling specified in this section and applicable to project.
- Results: Submit.

WORKMANSHIP GENERALLY

440B CONDITIONING OF CONCRETE BLOCKS

- Avoidance of suction in concrete blocks: Do not wet.
  - Use of water retaining mortar admixture: Submit details.

460 MORTAR GROUPS

- Mix proportions: For a specified group select a mix design from the following:
  - Group 1:
    1: 0–0.25: 3 (Portland cement: lime: sand with or without air entraining additive).
    1: 3 (Portland cement: sand and air entraining additive).
    Typical Use for Structural / high load-bearing masonry.
  - Group 2:
    1: 0.5: 4–5 (Portland cement: lime: sand with or without air entraining additive).
    1: 3–4 (Portland cement: sand and air entraining additive.)
    Typical Use for External walls, moderate exposure.
  - Group 3:
    1: 1: 5–6 (Portland cement: lime: sand with or without air entraining additive).
    1: 3.5–4 (masonry cement: sand containing Portland cement and lime in approximate ratio 1: 1, and an air entraining additive).
    General masonry (most blockwork, partitions)
  - Group 4:
    1: 2: 8–9 (Portland cement: lime: sand with or without air entraining additive).

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1: 4.5 (masonry cement: sand containing Portland cement and lime in approximate ratio 1: 1, and an air entraining additive).
Typical Use for Internal, non-loadbearing, sheltered.

- Materials:
  - Cement: BS EN 197-1, CEM I or CEM II
  - Masonry cement: BS EN 413-1
  - Sand: BS EN 13139, washed natural or crushed, graded for joint thickness.
  - Water: Potable, per BS EN 1008
- Batching: Mix proportions by volume.
- Mortar type: Continuous throughout any one type of masonry work.
- Additives: Optional air-entraining admixture per manufacturer, if required for frost resistance.

500A LAYING GENERALLY

- Mortar joints: Fill vertical joints. Lay solid and cellular blocks on a full bed.
- Bond where not specified: Half lap stretcher.
- Vertical joints in concrete block facework: Even widths. Plumb at every fifth cross joint.

520A ACCURACY

- Courses: Level and true to line.
- Faces, angles and features: Plumb.
- Permissible deviations:
  - Position in plan of any point in relation to the specified building reference line and/ or point at the same level ± 10 mm.
  - Straightness in any 5 m length ± 5 mm.
  - Verticality up to 3 m height ± 10 mm.
  - Verticality up to 7 m height ± 14 mm.
  - Overall thickness of walls ± 10 mm.
  - Level of bed joints up to 5 m (block masonry) ± 13 mm.

545 LEVELLING OF SEPARATE LEAVES

- Locations for equal levelling of cavity wall leaves: As follows:
  - Every course containing vertical twist type ties or other rigid ties.
  - Every third tie course for double triangle/ butterfly ties.
  - Courses in which lintels are to be bedded.

595 LINTELS

- Bearing: Ensure full length masonry units occur immediately under lintel ends.

635 JOINTING

- Profile: Consistent in appearance.

645 ACCESSIBLE JOINTS NOT EXPOSED TO VIEW

- Jointing: Struck flush as work proceeds.

665 POINTING TO ALL WALLING, WHERE INDICATED ON DRAWINGS

- Joint preparation: Remove debris. Dampen surface.
- Mortar: As section Z21.
  - Standard: To BS EN 998-2.

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  - Mix: 1:3 masonry cement: sand 6 N/mm² (mortar class 6).
  - Additional requirements: Bond strength: 10 N/mm².
- Profile: Bucket handle.

671 FIRE STOPPING

- Avoidance of fire and smoke penetration: Fit tightly between cavity barriers and masonry. Leave no gaps.

690A ADVERSE WEATHER

- Air temperature requirements: Do not lay blocks:
  - In cement gauged mortars when at or below 3°C and falling or unless it is at least 1°C and rising.
  - In hydraulic lime: sand mortars when at or below 5°C and falling or below 3°C and rising.
  - In thin joint mortar glue when outside the limits set by the mortar manufacturer.
- Temperature of walling during curing: Above freezing until hardened.
- Newly erected walling: Protect at all times from:
  - Rain.
  - Drying out too rapidly in hot conditions and in drying winds.

730 CONCRETE BLOCK SAMPLES

- General: Before placing orders with suppliers submit for approval of appearance labelled samples of the following: Blocks as in clause F10/355.
- Selection of samples: Representative of the range in variation of appearance.

740A FINISHED MASONRY WORK REFERENCE PANELS

- General: Before proceeding to construct the following walling types, construct panels as specified. Give notice when panels are dry.
- Selection of masonry units: Randomly to BS EN 771-3.
- Panel types:
  - Walling type: All.
    Location: as directed by Engineer and as indicated on drawings.
    Size: As directed by Engineer and as indicated on drawings.
    Other requirements: None.
- For landscaped boundary walls, add grooves, plaster and paint finish as indicated on landscape drawings.

745 MASONRY SAMPLE PANELS

- Sampling frequency: A panel for each type and delivery of masonry unit.
- Selection of masonry units: Randomly to BS EN 771-3.
- Panel types: As clause 740.

760 APPEARANCE

- Block selection: Do not use units with damaged faces or arrises.
- Cut masonry units: Where cut faces or edges are exposed cut with table masonry saw.
- Quality control: Lay masonry units to match relevant reference panels.
  - Setting out: To produce satisfactory junctions and joints with built-in elements and components.
  - Coursing: Evenly spaced using gauge rods.
- Lifts: Complete in one operation.
- Methods of protecting facework: Submit proposals.

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780 GROUND LEVEL

- Commencement of facework: Not less than 150 mm below finished level of adjoining ground or external works level.

800 TOOTHED BOND

- New and existing facework in same plane: Bond together at every course to achieve continuity.

830 CLEANLINESS

- Facework: Keep clean.
- Mortar on facework: Allow to dry before removing with stiff bristled brush.
- Removal of marks and stains: Rubbing not permitted.

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F30 ACCESSORIES/ SUNDRY ITEMS FOR BRICK/ BLOCK/ STONE WALLING

To be read with Preliminaries/ General Conditions.

CAVITIES

110 CONCRETE FILL TO BASE OF CAVITY

- Concrete generally: To BS EN 206 and BS 8500-2.
- Concrete type: Designated GEN1.
  - Workability: High.
- Extent: Maintain 75 mm between top of fill and external ground level and a minimum of 225 mm between top of fill and ground level DPC.
- Placement: Compact to eliminate voids.

120 CLEANLINESS

- Cavity base and faces, ties, insulation and exposed DPCS: Free from mortar and debris.

130 PERPEND JOINT WEEP HOLES

- Form: Open perpend joint.
- Locations: Through outer leaf immediately above base of cavity, at cavity trays, stepped DPCS and external openings. 75 mm above top of cavity fill at base of cavity.
- Provision: At not greater than 1000 mm centres and not less than two over each opening.

131 BED JOINT WEEP HOLES

- Form: Open 10 mm diameter hole.
- Locations: Through outer leaf immediately above base of cavity at cavity trays, stepped DPCS and external openings. 75 mm above top of cavity fill at base of cavity.
- Provision: At not greater than 1000 mm centres and not less than two over each opening.

132 PERPEND JOINT PLASTICS WEEP HOLES

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Locations: Through outer leaf immediately above base of cavity, at cavity trays, stepped DPCS and external openings. 75 mm above top of cavity fill at base of cavity.
- Provision: At not greater than 1000 mm centres and not less than two over each opening.

150A FULL FILL CAVITY INSULATION

- Insulation: Fire retardant Extruded polystyrene (XPS) boards to BS EN 13164.
- Type: Suitable for full-fill cavity applications.
- Density / Compressive Strength: Minimum CS (10)300 (≥ 300 kPa).
- Face/Barrier: Unfaced, unless otherwise indicated on drawings.
- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Recycled content: Contractor's choice.
- Face size (nominal length x width): To suit wall tie spacing.
- Thickness (nominal): As required to achieve the design U-value.
- Thermal conductivity: not greater than 0.029 W/ (m.K).

REINFORCING/ FIXING ACCESSORIES

214 CAVITY WALL TIES FOR ALL CAVITY WALLS, WHERE INDICATED

- Standard: To BS EN 845-1.

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  - Type: 1 (Masonry heavy duty).
- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Material/ finish: Austenitic stainless steel - material/ coating reference 1.
- Sizes: 250 mm, unless otherwise advised by Engineer to accommodate different cavity wall thicknesses.
- End types: Symmetrical butterfly loop or deformed plate or triangle unless otherwise indicated on drawings.
- Design embedment length (minimum): 50 mm.
- Movement: Nontolerant.
- Additional requirements: None.

225 FIXING TIES IN MASONRY CAVITY WALLS

- Embedment in mortar beds (minimum): 50 mm.
- Placement: Sloping slightly downwards towards outer leaf, without bending. Drip centred in the cavity and pointing downwards.
- Spacing: Staggered in alternate courses.
  - Horizontal centres: 900 mm.
  - Vertical centres: 400 mm.
- Additional ties: Provide within 225 mm of reveals of unbonded openings and at the vertical reveals of unsupported masonry.
  - Spacing: In every course.

228 FIXING TIES IN MASONRY CAVITY WALLS WITH FULL FILL CAVITY INSULATION

- Embedment in mortar beds (minimum): 50 mm.
- Placement: Sloping slightly downwards towards outer leaf, without bending. Drip centred in the cavity and pointing downwards.
- Spacing: Staggered in alternate courses.
  - Horizontal centres: 900 mm.
  - Vertical centres: 400 mm.
- Provision of additional ties:

    One row to support lowest row of insulation batts.
    Within 225 mm of reveals of unbonded openings and at the vertical reveals of unsupported masonry.
  - Spacing: In every course.

241 WALL STARTERS/ CONNECTORS

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Material/ finish: Austenitic stainless steel 316 for external applications, and galvanized steel for internal applications.
- Sizes: to suit wall thicknesses.

242 SURFACE MOUNTED CHANNELS/ SLOTS

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Material: Austenitic stainless steel.
- Type: Attached lug.
- Profile: Rectangular.
- Size (width x depth): as indicated.
- Length: 100 mm.

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- Fixing: Manufacturer's standard.

245 CHANNEL/ SLOT TIES as determined by Engineer

- Standard: To BS EN 845-1.
- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Material/ finish: Austenitic stainless steel - material/ coating reference 1.
- Sizes: as indicated.
- Channel/ slot fixing: Embedded.
- End types: Asymmetrical dovetail slot end with twisted plate surface end.
- Design embedment length (minimum): 50 mm.
- Additional requirements: None.

270 MESHWORK JOINT REINFORCEMENT GENERALLY

- Standard: To BS EN 845-3.
- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Type: Welded wire ladder type.
- Material: Austenitic stainless steel - material/ coating reference R1 to BS EN 845-3 for exterior applications and Zinc coated steel wire - material/ coating reference R13 to BS EN 845-3 for interior locations.
- Width: Approximately 40-50 mm less in width than wall or leaf.
- Placement: Lay on an even bed of mortar in a continuous strip with full laps at angles. Keep back 20 mm from face of external work, 12 mm back from face of internal work and finish joint to normal thickness.
  - Lap length (minimum): 225 mm.

281 LATERAL RESTRAINT PROPRIETARY SLIP TIES FOR MOVEMENT JOINTS GENERALLY

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals, subject to Engineer's approval.
- Material/ finish: Austenitic stainless steel - material/ coating reference 1.
- Fixing centres: Alternate courses.

282 GENERAL PURPOSE SLIP TIES FOR MOVEMENT JOINTS GENERALLY

- Standard: To BS EN 845-1.
- Manufacturer: Submit proposals.
  - Product reference: Submit proposals, subject to Engineer's approval.
- Material/ finish: Austenitic stainless steel - material/ coating reference 1.
- Sizes: as determined and recommended by manufacturer for the area of intended application.
- Shear load capacity: as recommended by Manufacturer.
- End types: Asymmetrical deformed plate and flat plate with slip case.
- Design embedment length (minimum): 50 mm.
- Additional requirements: None.
- Fixing centres: Alternate courses.

291 SPECIAL FIXINGS GENERALLY

- Type: Submit proposals.
- Material/ Finish: To PD 6697, clause 5.3.2.
- Performance: Of type, size, strength and number necessary to resist loads likely to occur during the life of the building and prevent lateral displacement or pulling apart of construction.

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- Placement: Fill pockets with bedding mortar finished flush where exposed to view.

FLEXIBLE DAMP PROOF COURSES/ CAVITY TRAYS

310 DAMP PROOF COURSE - BITUMEN BASED

- Standard: To BS 6398.
  - Class: B.
- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.

INSTALLATION OF DPCS/ CAVITY TRAYS

415 HORIZONTAL DPCS

- Placement: In continuous lengths on full even bed of fresh mortar, with 100 mm laps at joints and full laps at angles.
- Width: At least full width of leaf unless otherwise specified. Edges of dpc not covered with mortar or projecting into cavity.
- Overlying construction: Immediately cover with full even bed of mortar to receive next masonry course.
- Overall finished joint thickness: As close to normal as practicable.

425 GROUND LEVEL DPCS

- Joint with damp proof membrane: Continuous and effectively sealed.

435 STEPPED DPCS IN EXTERNAL WALLS

- External walls on sloping ground: Install DPCS not less than 150 mm above adjoining finished ground level.

445 SILL DPCS

- Form and placement: In one piece and turned up at back when sill is in contact with inner leaf.

455 COPING/ CAPPING DPCS

- Placement: Bed in one operation to ensure maximum bond between masonry units, mortar and DPC.
- DPCS crossing cavity: Provide rigid support to prevent sagging.

465 SEALING DPCS PARAPET WALLS

- Overlaps and junctions: Seal with Cold applied roofing felt adhesive.

560 VERTICAL DPCS GENERALLY

- Form: In one piece wherever possible.
  - Joints: Upper part overlapping lower not less than 100 mm.

570 JAMB DPCS AT OPENINGS

- Joint with cavity tray/ lintel at head: Full underlap.
- Joint with sill/ horizontal DPC at base: Full overlap.
- Projection into cavity: Not less than 25 mm.
- Relationship with frame: In full contact.

JOINTS

610 MOVEMENT JOINTS WITH SEALANT GENERALLY

- Joint preparation and sealant application: As section Z22.
- Filler: fire treated Closed cell polyethylene foam.

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  - Thickness: To match design width of joint.
  - Manufacturer: Submit proposals.
    Product reference: Submit proposals.
  - Placement: Build in as work proceeds with no projections into cavities and to correct depth to receive sealant system.
- Sealant:
  - Designation: ISO 11600-F-20LM.
  - Manufacturer: Submit proposals.
    Product reference: Submit proposals.
  - Colour: To match adjoining masonry.

615 MOVEMENT JOINTS WITHOUT SEALANT GENERALLY

- Filler: Fire treated Closed cell polyethylene foam.
  - Thickness: To match design width of joint.
  - Manufacturer: Submit proposals.
    Product reference: Submit proposals.
  - Placement: Build in as work proceeds filling the joint but without projecting into cavities.

616 FIRE RESISTANT MOVEMENT JOINTS WITHOUT SEALANT GENERALLY

- Fire resistant filler:
  - Thickness: to match design width of joint.
  - Fire resistance period: as indicated in Fire report.
  - Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
  - Placement: Compress and insert into place in open joint.
  - Adhesives and accessories: Types recommended by filler manufacturer.

630 UNEXPOSED CONTRACTION JOINTS

- Formation: Close butt as work proceeds.

650 POINTING IN FLASHINGS

- Joint preparation: Free of debris and lightly wetted.
- Pointing mortar: As for adjacent walling.
- Placement: Fill joint and finish flush.

670 TOPS OF NONLOADBEARING WALLS

- Restraints: to BS EN 845-1.
  - Fixing: Secure to soffit.
- Joint filler: fire treated closed cell polyurethane foam, where indicated on drawings.
  - Placement: Full, no gaps.

PROPRIETARY SILLS/ LINTELS/ COPINGS/ DRESSINGS

720 SILLS

- Standard: To BS 5642-1.
- Material: Precast concrete.
- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Dimensions: As shown on drawings allowable tolerance length - 6 mm, height and all other dimensions: +-3 mm.
- Finish: Smooth.

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- Mortar for bedding/ jointing: Cement gauged as section Z21.
  - Standard: To BS EN 998-2.
  - Mix: 1:3 masonry cement: sand (mortar class 6).
  - Additional requirements: None.
- Joints: Flush.
- Bedding one-piece sills: Leave bed joints open except under end bearings and masonry mullions. On completion, point to match adjacent work.

735 PRECAST CONCRETE LINTELS

- Standard: To BS EN 845-2.
- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Types: as indicated on drawings.
- Sizes: as indicated on drawings
- Additional requirements: as indicated on drawings.
- Placement: Bed on mortar used for adjacent work.
  - Bearing length (minimum): 100 mm unless otherwise indicated on drawings.

760 COPING UNITS

- Standard: To BS 5642-2.
- Material: Natural stone, or precast concrete or metal as indicated on drawings.
- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Dimensions: As shown on drawings.
- Finish: To match sample submitted to Engineer's approval.
- Mortar for bedding/ jointing: Cement gauged as section Z21.
  - Standard: To BS EN 998-2.
  - Mix: 1:3 masonry cement: sand (mortar class 6).
  - Additional requirements:
    Material density (Mean value to BS EN 1936:2006): 2550 kg/m³.
    Durability freeze-thaw (Mean values to EN 12371:2010): 8.5 MPa.
    Flexural strength (Mean value to BS EN 12372:2006): 8.5 MPa.
    Reaction to fire: Class A1.
    Open porosity: 7.5%.
    Water absorption (Mean value to BS EN 13755:2008): 2%.
- Resistance to fixing: (Mean value to BS EN 13364:2002): 2600 N.
- Joints: Full and finished flush.
- Placement: Lay on a full bed of mortar to line and level.

MISCELLANEOUS ITEMS

840 OPENINGS FOR FRAMES

- Formation: Use accurate, rigid templates to required size.

850 WALL PLATES

- Placement: On full bed of mortar to correct horizontal level.

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G10 - STRUCTURAL STEEL FRAMING

- To be read with Preliminaries/ General Requirements.

GENERAL

20 RELATED DOCUMENTS

- This section includes:
  - Structural Steel.
  - Shrinkage-resistant grout.
  - Architectural exposed structural steel.
  - Shear stud connectors.
- To be read with Drawings, Specifications, Bill of Quantities, and general provisions of the Contract, including General and Particular Conditions.
- To be read with:
  - Division “A” for “Quality Requirements” for independent testing agency procedures and administrative requirements.
  - Division “E” for “cast-in-place concrete on steel decking”.
  - Division “G” for “Metal Profiled Sheet Decking”.
  - Division “M” for “Painting and Fireproofing on Steel”.
  - Division “Q” for “Grating”.

30 INFORMATIONAL SUBMITTALS

- General: Submit each item in this section according to the Conditions of the Contract and Division A Specification Sections.
- Qualification data: Submit qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of engineers and employers, and other information specified. For each project, submit photographs showing details of installed AESS.
- Fabricator: Submit the name of the proposed fabricator with reference to works of a similar nature carried out by him on other projects, with relevant dates. Engage a firm experienced in fabricating structural steel similar to that indicated for this project and with a record of successful in-service performance, as well as sufficient production capacity of fabricate structural steel without delaying the works.
- Erector: Submit the name of the proposed erector with reference to works of a similar nature carried out by him on other projects, with relevant dates. Engage an experienced Installer who has completed structural steel works similar in material, design and extent to that indicated for this Project and with a record of successful in-service performance.
- Qualified engineer qualifications: A qualified Engineer who is legally authorized to practice in jurisdiction where Project is located and who is experienced in providing Engineering services of the kind indicated. Engineering services are defined as those performed for projects with structural steel framing that are similar to that indicated for this Project in material, design and extent.
- Quality control: Submit a method statement of the system of quality control to be used in fabrication and erection including proposed welding procedure complying with BS EN1011.

An approved quality control Engineer is to be assigned for the complete duration of the works to ensure proper performance.

- Surveys of existing conditions: Submit for information certified copies of each survey conducted by an approved engineer, showing elevations and locations of base plates and anchor bolts to receive structural steel, and final elevations and locations for major members. Indicate discrepancies between actual installation and contract documents.
- Quality system: Comply with ISO 9001/9002 Quality System as a minimum. Incorporate all the standard procedures supplied by the Engineer and the Employer.
- Product data: Submit producer's or manufacturer's specifications and installation instructions. Include mill test reports in accordance with EN standard relevant to each product, laboratory test reports and other data to show compliance with specifications (including specified standards) for the following products, but not limited to:
  - Structural steel (each type), including certified copies of mill reports covering chemical and physical properties.
  - Bolts, nuts, and washers, including mechanical properties and chemical analysis.
  - Tension-control, high strength bolt-nut-washer assemblies.
  - Direct-tension indicators.
  - Shear stud connectors.
  - Welding electrodes.
  - Anchor bolts.
  - Threaded rods.
  - Forged-steel hardware.
  - Shrinkage-resistant grout.
  - Bearing pads and stainless-steel plates.
  - Slide bearings.
  - Prefabricated building columns.
  - Shop primer.
  - Galvanized-steel primer and repair paint.
  - Etching cleaner.
- Welding certificates.
- Test reports: Submit copies of reports of tests conducted on shop and field bolted and welded connections. Include data on type(s) of tests conducted and test results. State compliance or non-compliance with specifications.
- Fabricator and erector: Submit the name of the proposed fabricator and erector with reference of works of a similar nature carried out by the company on other projects, with relevant dates.
- Surveys of existing conditions: Submit for information certified copies of each survey conducted by an approved engineer, showing elevations and locations of base plates and anchor bolts to receive structural steel, and final elevations and locations for major members. Indicate discrepancies between actual installation and contract documents.
- Method statement: Submit for approval, Quality Control method statement in accordance with quality assurance procedures, and Erection method statement. No fabrication works are to commence before approval of test reports and submittals.
- Source quality-control reports.
- Field quality-control reports.

40 DEFINITIONS

- Reference standards: Follow the latest edition in case any standard in this specification is superseded by newest version.
- Structural steel: Elements of structural-steel frame indicated on Drawings and as described in BS EN 1993-1-1, BS EN 1090-1 and -2.
- AESS: Architecturally exposed structural steel. Category as defined in the Architectural drawings and specifications in the Contract Documents.

50 PERFORMANCE REQUIREMENTS

- Engineering responsibility: Engage a fabricator who utilizes a qualified engineer to prepare calculations, shop drawings, and other structural data for structural steel members and connections. The fabricator shall be specialized, registered, and licensed for building structural steelwork according to the local building and construction Authority. The name of the structural steel fabricator and the location of the fabrication shall be submitted to the Engineer.
- Calculations: Submit clear, self-explanatory, easy to follow, and well documented calculation notes supporting each of the task along with softcopy of computer models conducted for the analysis/design. The contractor has to be ready to submit softcopy of the used programs with licensed copy and supporting manuals. Contractor has to be ready to validate any software, spreadsheets or homemade tools used in the analysis/design against the codes, and standards indicated in this Section, once requested by the Engineer.

60 ACTION SUBMITTALS

- General: Submit each item in this Article according to the Conditions of the Contract and Division “A” Specification Sections.
- Design calculations: For the extent of structural steel items shown on the project drawings, the contractor is to submit design criteria, reference codes and loads used, fully detailed computer analysis and design including input data file, analysis model, end restraints and the associated output diagrams of all straining actions, stresses and code checking in addition to design calculations for bolted and welded connections.
- Product data: As detailed in clause “Information Submittals” For each type of product indicated.
- Shop drawings: As detailed in clause “Drawings and Calculations Prepared by Contractor”.
- Welding procedure specifications (WPSs) and procedure qualification records (PQRs): Provide according to BS EN ISO 15607 to BS EN ISO 15613 - AWS D1.1/D1.1M, "Structural Welding Code - Steel", for each welded joint whether prequalified or qualified by testing, including the following:
  - Power source (constant current or constant voltage).
  - Electrode manufacturer and trade name, for demand critical welds

GENERAL REQUIREMENTS/ INFORMATION

111 CONTRACTOR'S DESIGN OF MEMBERS AND JOINTS OF STEEL STRUCTUTRES

- Design concept: In accordance to designated standards and criteria in the specifications, report, and drawings issued in the concept design stage.
- Design responsibility: Design and detail all steel members and joints to suit the conceptual layout detailed in the contract drawings.

- Other responsibilities: Contractor’s design of concrete encasement as per section E05.

- Structural requirements:
  - Design: Complete in accordance with the designated code of practice to satisfy specified performance criteria.
  - Connections: Design and detail joints to designated code of practiceAll moment connections are fully restrained (Rigid connections) as per BS EN 1993-1-8.
  - Fixings to foundations and walls: Design and detail fixings to concrete to designated code of practice.
  - Loads: The loads that shall be taken in the design are as follows:
    a. Basis of structural design: BS EN 1990: Basis of structural design.
    b. Dead Loads (D): Self weight of all components.
    c. Imposed actions are according to Eurocode 1, BS EN 1991-1-1: actions on structures - part 1-1: general actions — densities, Self-weight, imposed loads for buildings.
    d. Wind Loads (W): Wind loads according to Eurocode 1, BS EN 1991-1-4: actions on Structures - part 1-4: general actions - wind actions, considering the following: the fundamental basic wind velocity (as per project location) for 10 Min. Mean wind velocity with an annual risk of being exceeded of 0.02.
    e. Seismic Loads (E): Seismic loads according to Eurocode 8, BS EN 1998-1: design of structures for earthquake resistance, Part 1: general rules, seismic actions and rules for buildings. Ground acceleration and seismic parameters (as per project location).
    f. Temperature Variation (T): -/+ degrees C (as per project location).
    g. The design load combinations are as per BS EN 1990: Basis of Structural Design.
  - Additional requirements: Respect the architectural design intent and choose details consistent with the architectural wall sections, elevations, and image. Submit preliminary dimensions and configuration of the connections for the approval of the Engineer before starting the structural design of connections. The Engineer reserves the right to modify/confirm the shape of the connections to respect the architectural intent.
- Design and production information: Engage a fabricator who utilizes a qualified engineer to prepare calculations, shop drawings, and other structural data for structural steel members and connections. As Preliminaries section A31 and clause 120.

115 DESIGN CONSTRAINTS - GENERAL

- Members forming bracing systems or girders of lattice construction: Unless detailed or instructed otherwise, position so that their lines of action intersect at a point.
- Bolts:
  - Diameter (minimum): as per approved connection design**.**
  - Number per connection (minimum): as per approved connection design, with minimum of two bolts.
  - Other requirements: Choose bolt dimensions to ensure that threads do not occur in shear plane of joint. Choose suitable bolt length to ensure receiving the required washer and nuts with full tightening in threads.

- Punching of bolt holes: Permitted except when detailed otherwise. Enlarge holes with heat is not permitted.
- Welds: Full profile, fillet welds, minimum 6 mm or 0.7 smaller thickness of connected plates, whichever is smaller.
- Other constraints: Pre-set anchors shall not be replaced by post-anchors; Welded splice of any member to be full-penetration weld.
- Architecturally exposed structural steel: Engage a firm experienced in fabricating and erecting structural steel similar to that indicated for this Project. Provide qualification data for firms and persons assigned to execution of architecturally exposed structural steel elements and details, compliance with AISC. Refer to Architectural section related to Architecturally Exposed Structural Framing. Prepare mockups at least four weeks prior to fabrication to demonstrate aesthetical effects as well as qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for the final unit of Work:
  - Locate mockups on-site or in the fabricator's shop as directed by the Engineer. Mockups shall be full-size pieces unless the Engineer approves smaller models.
  - Notify the Engineer one week in advance of the dates and times when mockups will be available for review.
  - Obtain Engineer's approval of mockups before starting fabrication of final units.
  - Demonstrate the proposed range of aesthetic effects regarding each element listed under the fabrication heading below.
  - Mockup will have finished surface including surface preparation and paint system.
- Products and equipment: shall demonstrate compliance with sustainability targets and requirements.

116 DESIGN CONSTRAINTS - STEELWORK TO BE GALVANIZED

- Steel grades: Do not use steel downgraded from a higher specification.
- Detail design: Avoid details that will increase the risk of initiating liquid metal assisted cracking (LMAC).
- Particular restrictions: Avoid asymmetrical sections; Avoid redundant members in latticed construction; Balance primary welds on either side of section access; Restrict changes in material thickness ratio, thick to thin, to less than 2.5:1; Round corners of rectangular web openings; Use bolted cleat connections; Use fillet welds for attachment of brackets; Use full end plates and stiffeners.
- Other requirements: Drill holes for bolts; Grind exposed cut edges and notches; Seal vent and drainage holes in hollow sections using non-ferrous plugs.

124 DRAWINGS AND CALCULATIONS PREPARED BY CONTRACTOR

- Information required: As project schedule.
- Requirements: Before preparing detailed fabrication drawings, submit General arrangement drawings: Submit before preparing calculations. Clearly identify:
  - Individual steel members.
  - Conflicts with other work.
  - Proposed changes to contract drawings.
  - Preliminary submittal showing proposed conceptual typical connection details with the design methodology, sample calculations, etc.

  - Detailed comprehensive design submittals of all connections substantiated with structural calculations performed using approved speciality software (IdeaStatica, Ram, Limcon, etc.). Design submittals shall include soft/native copy of the design connection runs and shall be signed and sealed by the qualified Engineer responsible for their preparation.
- Member and joint calculations: Submit for approval before preparing fabrication drawings.
- Structural-steel connections: Submit and comply with design loads, include structural analysis data signed and sealed by the qualified Engineer responsible for their preparation.
- Methods of erection and calculations of erection stability and stresses: Submit for all stages of constructions including methods of bracing and temporary guys.
- Shop drawings: Signed and sealed submission by a qualified Engineer responsible for their preparation. Show fabrication of structural-steel components include:
  - Details of cuts, connections, splices, camber, holes, and other pertinent data.
  - Embedment drawings.
  - Welds by standards symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain.
  - Type, size, and length of bolts, distinguishing between shop and filed bolts. Pre-tensioned and slip-critical high-strength bolted connections.
  - Setting drawings, templates, and directions for installation of anchor bolts and other anchorage to be installed as works of other sections.
  - Members and connections of the seismic-load resisting system. Locations and dimensions of protected zones. Demand critical welds.
  - Identify methods of bracing and temporary guys.
  - Identify members not to be shop primed.
  - Include detailing fabrication of architecturally exposed structural steel AESS.
  - Setting drawings, templates, and directions for installation of anchor bolts and other anchorage to be installed as works of other Sections.
  - For structural-steel connections, include structural analysis data signed and sealed by the qualified engineer responsible for their preparation.
- As-built drawings: At project close-out, submit record "As-Built" drawings of completed works products, in accordance with requirements of specifications.
- Shop and erection drawings: Shall be substantiated with calculation notes including soft copies of any connection design model or spreadsheets. Any In-house design spreadsheets shall be validated with sample hand calculations.

125 SPECIFICATION STANDARD

- Standard: Comply with latest edition of National Structural Steelwork Specification (NSSS CE Marking version).
  - Additional requirements: Substitution of reference standards and other requirements from BS EN 1090-2 (for the execution of steel structures in compliance with Eurocode 3) when these differ from those given in the NSSS CE Marking version (see general guidance 5.1), Requirement to comply with a BS EN 1090-2 execution class, e.g. EXC2, in addition to the NSSS CE Marking version, Requirements for members supporting dynamic or vibrating loads or subject to fatigue, Submission of completion certificate.

  - Document availability: For the duration of the work, at fabrication shop and on site.
- References to engineer in NSSS CE marking version: For the purpose of this contract, interpret such references as being to the person named in section A10 as Consulting Structural Engineer, the person named in section A10 as administering the contract on behalf of the Employer.
  - Exceptions: Functions indicated in Design stage 1 and 2 checklists as being delegated to the Engineer appointed by the Contractor, Functions indicated in Design stage 1 and 2 checklists as being reserved for the Employer's Consulting Structural Engineer.
- Products: Follow the latest edition in case any standard in this specification is superseded by newest version.
  - BS 3692:2014 "ISO metric precision hexagon bolts, screws and nuts. Specification."
  - BS EN ISO 5817:2014 "Welding. Fusion-welded joints in steel, nickel, titanium, and their alloys (beam welding excluded). Quality levels for imperfections."
  - BS 7668:2016 "Weldable structural steels. Hot finished structural hollow sections in weather resistant steels. Specification."
  - BS EN ISO 9445 (all parts) "Continuously cold-rolled stainless steel. Tolerances on dimensions and form."
  - BS EN 10027-1:2016 "Designation systems for steels. Steel names."
  - BS EN 10029:2010 "Hot-rolled steel plates 3 mm thick or above. Tolerances on dimensions and shape."
  - BS EN 10034:1993 "Structural steel I and H sections. Tolerances on shape and dimensions."
  - BS EN 10048:1997 "Hot rolled narrow steel strip. Tolerances on dimensions and shape."
  - BS EN 10051:2010 "continuously hot-rolled strip and plate/sheet cut from wide strip of non-alloy and alloy steels. Tolerances on dimensions and shape."
  - BS EN 10055:1996 "Hot rolled steel equal flange tees with radiused root and toes. Dimensions and tolerances on shape and dimensions."
  - BS EN 10056-1:2017 "Structural steel equal and unequal leg angles. Dimensions."
  - BS EN 10056-2:1993 "Structural steel equal and unequal leg angles. Tolerances on shape and dimensions."
  - BS EN 10095:1999 "Heat resisting steels and nickel alloys."
  - BS EN 10163 (all parts) "Delivery requirements for surface condition of hot-rolled steel plates, wide flats and sections."
  - BS EN 10164:2018 – Steel products with improved deformation properties perpendicular to the surface of the product. Technical delivery conditions."
  - BS EN ISO 10684:2004 "Fasteners. Hot dip galvanized coatings."
  - BS EN ISO 14341:2020 "Welding consumables. Wire electrodes and weld deposits for gas shielded metal arc welding of non-alloy and fine grain steels. Classification."
  - BS EN ISO 16810:2014 "Non-destructive testing. Ultrasonic testing. General principles.
  - BS EN ISO 17659:2004 "Welding. Multilingual terms for welded joints with illustrations."
  - SCI/NSSS – National Structural Steelwork Specification for Building Construction – CE Marking Version; 2020 (7th Edition)."

- Design codes: Comply with applicable provisions of the following specifications and documents. Follow the latest edition in case any standard in this specification is superseded by newest version.
  - BS EN 1990:2005 “Eurocode. Basis of structural design.”
  - BS EN 1991-1 (all parts) “Eurocode 1. Actions on structures. General actions.”
  - BS EN 1993-1-1:2014 “Eurocode 3. Design of steel structures. General rules and rules for buildings.”
  - BS EN 1993-1-3:2006 “Eurocode 3. Design of steel structures. General rules. Supplementary rules for cold-formed members and sheeting.”
  - BS EN 1993-1-8:2005 “Eurocode 3. Design of steel structures. Design of joints.”
  - BS EN 1994-1-1:2004 “Eurocode 4. Design of composite steel and concrete structures. General rules and rules for buildings.”
  - BS EN 1998-1:2004 “Eurocode 8. Design of structures for earthquake resistance. General rules, seismic actions and rules for buildings.”

PRODUCTS

130 GENERAL STEEL SECTIONS AND PLATES

- Standard: To BS EN 10025-1 to 6.
  - Grade: S355JR, or approved equal, typically used unless noted otherwise; S275JR, or approved equal, used only when specified; S235JR, or approved equal, used only when specified.
  - Options: for galvanized steel to BS EN 10025.
- Source: Obtain steel from a source accredited to a national or internationally accepted quality standard.
- Other requirements: Steel to be galvanized to have a carbon equivalent value not exceeding 0.44.

135 HOLLOW STEEL SECTIONS

- Standard: To BS EN 10210-1 for hot finished sections, BS EN 10219-1 for cold formed welded sections.
- Grade: 355JR, or approved equal, typically used unless noted otherwise; S275JR, or approved equal, used only when specified; S235JR, or approved equal, used only when specified.
  - Options: For galvanized steel to BS EN 10210.
- Source: Obtain steel from a source accredited to a national or internationally accepted quality standard.
- Other requirements: Steel to be galvanized to have a carbon equivalent value not exceeding 0.44.

140 WELDS

- Welding materials: Conform to BS EN 1011-1 and -2 and relevant EN standards for consumables - AWS Code and AWS Filler Metal Specifications. Select materials which are suitable for use with types of steel to be joined. Unless otherwise indicated, connections are designed for:
  - Metal-Arc Welding Electrodes: to E42 (Table 1A) per BS EN ISO 2560, BS EN ISO 14171, BS EN ISO 26304, equivalent to E70XX series of the Specification for Mild

Steel Covered Arc-Welding Electrodes, AWS A5.1, or the Specification for Low-Alloy Steel Covered Arc-Welding Electrodes, AWS A5.5.

- Bare Electrodes and Granular Flux used in the submerged-arc process are to conform to BS EN ISO 14171, BS EN ISO 14174, BS EN ISO 26304, equivalent to F7 X-EXXX AWS flux classifications of the Specification for Base Mild Steel Electrodes and Fluxes for Submerged Arc Welding, AWS A5.17, or A5.23 or the of AISC "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings".

141 SHEAR CONNECTORS

- Connector type: Headed stud shear connectors (SD).
- Standard: Headed-stud type, cold finished carbon steel, to BS EN 13918, BS EN 1994-1-1, and BC1, with a minimum yield stress of 345 N/mm2, nominal tensile strength of 450 N/mm2, and minimum elongation of 14%, both in cold drawn condition, when tested in accordance with the relevant European standard or equivalent AWS, and applied in accordance with Recommended Practices for Stud Welding
  - Size/ spacing: as shown on drawings.
- Source: Obtain material from a source accredited to a national or internationally accepted quality standard.
- Welding method: Shot fired pins, Drawn arc stud welding, 6 mm fillet welds.
- Procedure trials: Required.
- Other requirements:
  - Do not arc weld studs through more than one layer of decking.
  - Check the thickness of flanges and webs for the minimum requirements before welding.
  - Check the length for the minimum requirements to exceed the depth of deck corrugation.
  - Prepare steel surfaces as recommended by manufacturer of shear connectors. Shop weld shear connectors, spaced as shown, to beams and girders in composite construction. Use automatic end welding of headed-stud shear connectors according to BS EN 13918, BS EN 1994-1-1, AWS D1.1/D1.1M and manufacturer's printed instructions.

170 COLD-FORMED GALVANIZED STEEL PURLINS/ SIDE RAILS

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Material: Galvanized steel sheet to BS EN 10346.
  - Thickness: As per the approved calculations provided by supplier. This to be submitted for engineer’s review and approval.
  - Designation: As per the approved calculations provided by supplier. This to be submitted for engineer’s review and approval. Minimum S350GD+Z.
  - Any missing members shall be designed by the contractors/manufacturer.

171 OTHER SECTIONS

- Stainless steel plates for Teflon bearings: to conform to BS EN 10088-2 with a minimum 0.2% proof strength of 345 MPa or equivalent.
- Polytetrafluoroethylene: Polytetrafluoroethylene (PTFE) sheets are to conform to EN relevant standards – ASTM D 4894 and 4895.
- Seam stitching:

  - Fixings/ centres: 4.8 mm diameter self-drilling screws at 800 mm centres, installed from underside of sheet**.**
  - Coating applied by manufacturer: Sherardized or galvanized**.**
- Steel castings: EN relevant standards - ASTM A216/A216M, Grade WCB, with supplementary requirement S11.
- High strength steel castings: Conform to EN relevant standards - ASTM A148/A148M grade 795-655.
- Steel forgings: EN relevant standards - ASTM A668/A668M
- Clevises and turnbuckles: EN relevant standards made from cold-finished carbon steel bars - to ASTM A108, Grade 1035.
- Eye bolts and nuts: EN relevant standards made from cold-finished carbon steel bars - to ASTM A108, Grade 1030.
- Sleeve nuts: EN relevant standards made from cold-finished carbon steel bars - to ASTM A108, Grade 1018.

176 PROFILED SHEET FOR SHUTTERING/ COMPOSITE FLOOR SLABS

- Refer to section G30 related to METAL PROFILED SHEET DECKING.

FABRICATION

180 NOTIFICATIONS OF COMMENCEMENT

- Notice: Obtain permission of the Engineer before starting fabrication Give notice before fabrication is due to start.
  - Period of notice (minimum): [Five working days].
- General for fabrication:
  - Camber structural steel members where indicated.
  - Fabricate for delivery a sequence that will expedite erection and minimize field handling of structural steel.
  - Complete structural steel assemblies, including welding of units, before starting shop-priming operations.
  - Comply with fabrication tolerance limits as per standards.
  - Holes: Cut, drill, or punch standard bolt holes perpendicular to metal surface. Do not flame-cut holes or enlarge holes by burning. Drill holes in bearing plates. Provide holes required for securing other works to structural steel framing and for passage of other works through steel framing members, as shown on Shop Drawings.
  - Bolt field connections, except where welded connections or other connections are indicated. Do not distort or enlarge holes when using drifts. Do not use drifts of large diameter than holes. Report any misalignment of holes. Reaming of holes will not be allowed except for minor connections, and subject to written approval from the Engineer.

185 SEQUENCES

Unless noted otherwise and approved:

- Submit source quality-control reports.
- Obtain permission of the Engineer before starting fabrication.
- Fabricate for delivery a sequence that will expedite erection and minimize handling of structural steel.

- Where finishing is required, complete assembly, including welding of units, before starting of finishing operations. Provide finish surfaces of members exposed in final structure free of markings, burrs, and other defects.
- Comply with fabrication tolerance limits of standards.
- Mark and match-mark materials for field assembly.
- Accurately mill ends of columns and other members transmitting loads in bearing.

190 MARKING

- Identifying and recording materials and components: Submit details of proposed methods.
- Location of marks:
  - Generally: Visible for checking after erection.
  - Weathering steel: On surfaces not exposed to open view in the completed work.
- Steel to be blast cleaned, pickled, and metal sprayed or galvanized: Marked so that subsequent treatment cannot obliterate the marking.

195 HARD STAMPING

- Usage: Not permitted except as indicated on drawings.

200 FAYING SURFACES FOR PRELOADED JOINTS

- Location: Surfaces which are to receive special treatment to be identified.
- Steel 25 mm thick or over: Check faying surfaces for deformities that may reduce slip factor to below design limit.
  - Remedial measures: Submit proposals
- Preparation/ treatment: [As required for friction surface class category specified in approved design to BS EN 1993-1-8].

205 EXPOSED STEEL

- For fabrication of works which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, rust and scale seam marks, roller marks, rolled trade names and roughness. Remove such blemishes by grinding, or by welding and grinding, prior to cleaning, treating and application of surface finishes.
- For the entire project: Use new steel, well and cleanly rolled to the dimensions, sections and weights specified, sound and free from cracks, surface flaws, laminations, and other defects, finished in a workmanlike manner. Supply certified materials that comply with the specifications and documents listed in this specification. Supply to the Engineer a summary list of the rolling mills and manufacturers from which it is proposed to obtain the steel sections, plates, forgings, and fixings.

210 END CONNECTIONS

- Angle cleats: Project 10 mm beyond ends of simply supported members.
- Finishing: Accurately mill ends of columns and other members transmitting loads in bearing.

215 HOLLOW SECTIONS

- Insides of sections: Debris and moisture removed before sealing ends and openings.
- Holes: Sealed to prevent access of moisture.
  - Method of sealing: Welding cap plate with thickness as shown on drawing.

217 CAMBERS

- Camber structural steel where indicated and comply with tolerance limits as per standards.
- Fabricate beams with rolling camber up.

218 SHOP CONNECTIONS

- Weld shop connections.

219 HOLES FOR BOLTS

- Cut, drill, or punch standard bolt holes perpendicular to metal surface.
- Do not flame-cut holes or enlarge holes by burning.
- Drill holes in bearing plates.
- Perform pre-installation verification as indicated in EN standards - RCSC prior to installation.
- Provide holes required for securing other works to structural steel framing and for passage of other works through steel framing members, as shown on shop drawings.
- Do not distort or enlarge holes when using drifts.
- Do not use drifts of large diameter than holes.
- Report any misalignment of holes.
- Reaming of holes will not be allowed except for minor connections, and subject to written approval from the Engineer.
- Bolted Connections: Bolted connections will be tested and inspected according to EN standards - AISC specifications and RCSC's "Specification for High-Strength Bolts". For pretension and slip critical joints, follow inspection as mentioned in EN standards - RCSC using Direct-Tension Indicator Pretensioning method.
  - Direct-tension indicator gaps will be verified to comply with BS EN 14399, BS EN ISO 898, ASTM F959/F959M, Table 2, F2437/F2437M.

220 ACCESS/ VENTILATION HOLES IN BASE PLATES

- Base plates larger than 1 m², or the smaller width larger than 600 mm Make 25 mm diameter holes as necessary for pressure grouting, escape of entrapped air or direct compaction of filling/ bedding material after erection of columns.

225 STEELWORKS TO BE GALVANIZED

- Standards: Apply zinc coating by the hot-dip process to structural steel according to BS EN ISO 14713, and ASTM A123 for American Standards.
- Cutting, drilling and shop welding: Complete before galvanizing.
- Vent and drain holes: Provide as necessary.
  - Locations: Submit proposals.
  - Sealing: Required, submit proposals

235 SHOP INSPECTION

- Give notice: Before fabricating.
  - Period of notice (minimum): [Three working days].

240 TRIAL SHOP ASSEMBLY

- Check fit, profile and camber before making connections in lattice girders and trusses which are assembled before delivery to site.
- Make trial assemblies of parts of structure.

- Component: Fabricate and assemble structural steel in shop to greatest extent possible.
- Give notice: Before commencing trial assembly.
  - Period of notice (minimum): [Three working days].

WELDING

250 WELDING PROCEDURES

- Quality management systems: To BS EN ISO 3834-3.
- Welding Procedure Specifications (WPSs) and Procedure Qualification Records (PQRs): Provide for each welded joint whether prequalified or qualified by testing, including power source (constant current or constant voltage), and electrode manufacturer and trade name, for demand critical welds.Certification of welders: [the steelwork contractor's system for the management of welding shall meet the standard quality requirements described in BS EN ISO 3834-3].
  - Third party certification: To BS EN ISO 9606-1.
  - Verification of welding procedures: Submit for Engineer's review and approval.
  - Welding procedure qualification records: To BS EN ISO 15614-1.
  - Provide evidence of welder's competence to undertake specified works. Welders must have been tested to the Standard Code using thickest plate specified and/or, material with highest carbon content, electrodes of appropriate class, welding positions which will be used in the works. Test Welder's competence to undertake special welding procedures when instructed.
- Special welding procedures:
  - Location: To be given where special welding procedures are needed. See BS EN ISO 15609-1.
  - Requirement: Submit procedure.

255 SITE WELDING

- Usage: unless otherwise indicated on the Drawings site welding will only be permitted for minor connections subject to written approval by the Engineer.
- Working conditions: Suitable and safe. Do not weld when surfaces are wet or when ambient temperature is below 0°C.

260 BUTT WELDS

- Use run on and run off plates to ensure full throat thickness at ends of butt welds.
- Material for plates is to be identical to material being welded.
- Prepare plates in same manner as parts being joined.
- Size of run on and run off plates to be 75 mm x 75 mm.
- After completion of welding remove plates and grind surfaces of joined parts where plates are attached to make smooth.
- Retain and identify plates for inspection when requested.

270 ADDITIONAL WELDS

- Welds (including tack welds) not indicated on drawings: Not permitted without approval.

BOLT ASSEMBLIES

302 NON-PRELOADED BOLT ASSEMBLIES

- To be used where specified only under the engineer approval.
- Designation: Countersunk bolts to BS 4933, grade 4.6. Countersunk bolts to BS 4933, grade 8.8. Cup bolts to BS 4933, grade 4.6. Cup bolts to BS 4933, grade 8.8. Hexagon head bolts to BS EN ISO 4014, grade A. Hexagon head bolts to BS EN ISO 4014, grade B. Hexagon head bolts to BS EN ISO 4016, grade C. Hexagon head screws to BS EN ISO 4017, grade A. Hexagon head screws to BS EN ISO 4017, grade B. Hexagon head screws to BS EN ISO 4018, grade C.
  - Threading: Part length for fitted bolts, otherwise full length. Part length for bolts to column splice plates, otherwise full length to suit design criteria
- Nuts and washers: To suit grade of bolt, as NSSS CE Marking version, clause 2.4.3.
- Coating applied by manufacturer: [Galvanized], [Sherardized] [Zinc plated].
- Other requirements: Provide additional washers under the nut as necessary]; [Bolts to beams supporting plant loads to be provided with lock nuts; Threaded length of fit bolts to BS EN 1993-1-8, clause 3.6.1.]; [For sections less than 4 mm thick, provide washers under both head and nut.

303 PRELOADED BOLT ASSEMBLIES

- Designation:
  - BS EN 14399-3, property class 8.8, system HR. BS EN 14399-3, property class 10.9, system HR. BS EN 14399-4, property class 10.9, system HV. BS EN 14399-7, property class 8.8/8, system HR with countersunk head. BS EN 14399-7, property class 10.9/10, system HR with countersunk head. Hexagon fit bolt assemblies to BS EN 14399-8, property class 10.9/10, system HVP. Hexagon head bolt assemblies to BS EN 14399-10, property class 10.9/10, system HRC. Cup head bolt assemblies to BS EN 14399-10, property class 10.9/10D, system HRC. Fit bolts to BS EN 14399-7, property class 10.9, system HV with direct tension indicators to BS EN 14399-9.
- Nuts and washers: To suit grade of bolt, as NSSS CE Marking version, clause 2.4.4.
- Coating applied by manufacturer: galvanized or Sherardized.

304 PROPRIETARY BOLT ASSEMBLIES

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.

305 PROPRIETARY ANCHORS TO CONCRETE, [TO 14 N DENSE CONCRETE BLOCKS, TO EXISTING STONE MASONRY

- Manufacturer: Submit Proposal.
  - Product reference: Submit proposals.
- Anchor type: Bonded anchor; Thick-walled sleeve expansion anchor. Bonded internally threaded sleeve with bolt. Intended bolt. Rebar bolt. Rag bolt.
- Material: Carbon steel; stainless steel.

310 ANCHORAGES TO CONCRETE

- Design standard: As the designated code of practice.
- Anchor type: Pre-set anchors or Bonded anchor as indicated on the drawings.

- Material: EN ISO 898-1 Grade 8.8, or EN ISO 898-1 Grade 10.9.
  - Coating applied by manufacturer: Galvanized.
- Concrete:
  - Grade: refer to section E10.
  - Condition: cracked.
- Characteristic resistances of single anchor remote from edge of concrete (minimum):
  - Tension: As shown on drawing or as per approved calculations.
  - Shear: As shown on drawing or as per approved calculations.
- Fixing in concrete: As per drawings: Pre-set anchors installed within customized templates, prior to casting of concrete or Bonded into predrilled hole using chemical bonding agent.

325 DIRECT TENSION INDICATORS

- To be used for all pretensioned bolted assemblies
- Standard: To BS EN ISO 898-1, BS EN 14399-9.
- Grade: Appropriate for grade of bolt and nut assembly.
- Finish: Plain (as processed).
- Ancillary components: Washers to BS EN 14399-9.
- Post installation and inspection treatment: Where no further protective coating is specified, apply a butyl rubber sealing compound to seal measuring gap around indicators.

335 SPRING WASHERS

- Standard: To BS 4464.

370 GALVANIZED COATING TO BOLT ASSEMBLIES

- Standard: To BS 7371-6.
- Galvanizing: Applied by fastener manufacturer. Passivated and lubricated if no additional coatings are specified. Nuts tapped after galvanizing.
- Use/location: All shop and site connections in shop painted steelwork.

375 SHERARDIZED COATING TO BOLT ASSEMBLIES

- Standard: To BS 7371-8.
  - Class: 30
- Sherardizing: Applied by fastener manufacturer and passivated.
- Post treatment: Sealed - inorganic or organic sealant. Lubricant: Commonly, molybdenum disulphide. Reduces torque required to turn nuts, making them easier to put on Zinc Phosphated (passivated).
- Use/location: All shop and site connections in shop painted steelwork.

380 ZINC PLATED FINISH TO BOLT ASSEMBLIES

- Standard: To BS EN ISO 4042.
  - Designation: as shown on drawing. A7L.
- Zinc plating: Applied by fastener manufacturer. Clear passivated if no additional coatings are specified. Nuts tapped after plating.
- Use/ location: All shop and site connections in shop painted steelwork.

390 SEALED HOLLOW SECTIONS

- Holes: Sealed to prevent access of moisture.

- Method of sealing: [Submit proposals].

ERECTION

405 OUTLINE METHOD OF ERECTION

- Outline method statement of erection is to be submitted for approval.
- Set structural steel accurately in locations and to elevations indicated and according to NSSS CE marking version, BS EN 1090-1 and -2, ANSI/AISC. Consider the followings:
  - Ensure that the capacity of plant and equipment used for erection are suitable and are in first class working order.
  - Obtain permission before starting erection of steelwork. Do not use welding equipment on site without approval.
  - Align and adjust various members that form part of complete frame or structure before permanently fastening.
  - Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members.
  - Clean concrete- and masonry-bearing surfaces of bond reducing materials and roughen surfaces prior to setting columns base plates. Clean bottom surface of plates.
  - Verify elevations of concrete- and masonry-bearing surfaces and location of anchor rods, bearing plates, and other embedment for compliance with requirements.
  - Notify the Engineer when space beneath any column base is less than 10 mm or more than 50 mm.
  - In the presence of shear key pocket, pre-set anchors to be out of pocket fully embedded in concrete to avoid bending during erection.
  - Perform necessary adjustments to compensate for discrepancies in elevations and alignment. Proceed with installation only after unsatisfactory conditions have been corrected.
  - Weld plate washers to top of base plates. Not to be welded if shear key is used.
  - Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but. if protruding, cut off flush with edge of plate before packing with grout.
  - Promptly pack grout solidly between bearing surfaces and plates so no void remains. Neatly finish exposed surfaces, protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistance grout.
  - Level and plumb individual members of structure.
  - Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in specifications for mill material.
  - Comply with Specifications for bearings, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
  - Make allowance for difference between temperature at time of erection and mean temperature when structure is complete and in service.
  - Splice members only where indicated.
  - Do not use thermal cutting unless approved by the Engineer. Finish thermally cut sections within smoothness limits.
  - Do not enlarge unfair holes in members by burning or using drift pins. Ream holes that must be enlarged to admit bolts.

- For shear connectors: Prepare steel surfaces as recommended by manufacturer of shear connectors. Use automatic end welding of headed-stud shear connectors according to standards BS EN 13918, BS EN 1994-1-1, AWS D1.1/D1.1M and manufacturer's written instructions.
- For slotted holes: Ensure bolts are in center of holes after erection of structure and ensure that washers of anchors are not welded to base plate.
- Treat sliding surfaces of proprietary joints in accordance with manufacturer's recommendations before connecting.
- Ensure bolts are in center of slotted holes after erection of structure.
- Use double nuts (finger tight nut to allow movement plus lock nut) for bolts in slotted holes with non-friction type connection.
- For architecturally exposed structural steel: Remove erection bolt on welded, and fill holes with plug welds, and grind smooth at exposed surfaces. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.

- Verify that weld sizes, fabrication sequence, and equipment used for architecturally exposed structural steel will limit distortions to allowable tolerances. Prevent surface bleeding of back-side welding on exposed steel surfaces. Grind smooth exposed fillet welds 13 mm and larger, and flush butt welds. Dress exposed welds.

406 FIELD CONNECTIONS

- Bolt filed connections, except for welded connections or other connections are indicated.
- Perform pre-installation verification for bolted field connections prior to installation.
- High-Strength Bolts: Install high-strength bolts according to Standards for type of bolt and type of joint specified. For pretension and slip critical joints, follow installation and inspection as mentioned in standards using Direct-Tension Indicator Pretensioning method.

410 PRE-ERECTION CHECKS

- Scope: At least 7 days before proposed erection start date, check the following:
  - Foundations and other structures to which steelwork will be attached: Accuracy of setting out.
  - Holding down bolts: Position, protruding length, slackness and condition.
- Inaccuracies and defects: Report without delay.
- Permission to commence erection: Obtain.

415 DELIVERY, STORAGE, HANDLING AND SEQUENCING

- Deliver structural steel to Project site in such quantities and at such times to ensure continuity of installation.
- Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, platforms, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
- Store fasteners in a protected place in sealed containers with manufacturer's labels intact. Fasteners may be repackaged provided independent testing and inspecting agency observes repackaging and seals containers. Clean and relubricate bolts and nuts that become dry or rusty before use. Comply with manufacturer's written recommendations for cleaning and lubricating fasteners and for retesting fasteners after lubrication.

- Manufactured items are to be delivered in original packages, containers, …etc bearing name of manufacturer and brand. Each piece of material is to bear the official grade and trade mark of the association under whose rules it is graded, or is to be accompanied by a certificate of inspection issued by that association.
- Protect steel works by approved adequate measures from constructional hazards during and after erection.
- Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete or masonry, in ample time to not to delay works.
- Supply and coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the works. Provide setting diagrams, templates, instructions, and directions as required, for installation.

420 SETTING OUT

- Permissible deviations: In addition to the requirements of the NSSS CE Marking version, add permissible deviations for different types of dimension and locations, as necessary.
- Supply and Coordinate installation of anchorage items to be embedded in or attached to other construction without delaying the works. Provide setting diagrams, templates, instructions, and directions, as required, for installation.

425 MODIFICATIONS

- Steelwork: Do not modify without approval.
- Temporary fabrication/ erection attachments: May remain when they will not interfere with subsequent work, and will be completely hidden by finishes; otherwise, remove.

432 TEMPORARY SUPPORT

- Permanent bracing system:
  - Vertical: as detailed on drawings.
  - Horizontal: as detailed on drawing.
- Temporary bracing/ restraints: Provide as necessary until permanent bracing system is complete and sufficiently mature to carry loads and all connections have been made to the permanent system. Do not remove temporary shoring supporting composite deck construction (propped type) until cast-in-place concrete has attained its design compressive strength.
- Elements to be supported: as detailed on drawing.
- Bracing/ Restraints: Provide as necessary until permanent connection can be made to floor structure, and as detailed on drawing.
- Forces and moments in temporary supports: As per contractor's method statement of erection and supporting calculations.

440 COLUMN BASES

- Levels: Clean concrete- and masonry-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates; Adjust using steel shims or folding wedges no larger than necessary.
- Location of shims/ wedges: Position symmetrically around perimeter of base plate. Do not use a single central pack.
- Give notice: If space beneath any column base is outside specified limits for bedding thickness.

- Accuracy of erection: Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedment for compliance with requirements. Check, and correct errors before filling and bedding beneath bases and carrying out other adjacent work. Weld plate washers to top of base plate. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
- Proceed with installation only after unsatisfactory conditions have been corrected.

441 GROUT FILLING/ BEDDING OF COLUMN BASES

- Bedding thickness range: 25–40 mm unless noted otherwise on drawings.Bolt pockets: Completely filled with neat cement slurry. ; Check pre-set anchors to be out of pocket, embedded in concrete during erection.
- Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces, protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.Spaces beneath base plates:
  - NON-SHRINK RHEOPLASTIC EXPANSIVE CEMENT GROUT: free flowing, non-shrink, non-ferrous rheoplastic, oil resistant and water resistant; complying with CE-CRD-C621 and having minimum compressive strength of 60 MPa; or equal.
- Additives: Not required.

443 PROPRIETARY FILLING/ BEDDING OF COLUMN BASES

- Bedding thickness range: 25-40mm.
- Preparation: Concrete surfaces scarified to provide a good mechanical key.
- Bolt pockets and spaces beneath base plates: Completely filled with approved grout filling.

445 MOVEMENT JOINTS

- Joint type: as shown on drawings. Bolts in shear in slotted holes, laminated neoprene bearing. Sliding bearing surfaces coated with molybdenum disulphide grease. Sliding bearing with a polished, austentic stainless steel upper surface sliding on a PTFE layer. Solid rubber bearing, submit proposal for approval.
  - Requirements: Shouldered bolts fitted with washer, spring washer, nut and lock nut]. [Anchor bolts in slotted holes as per drawings, and fitted with spring washers and self-locking nuts, cadmium plated to BS EN 2133].
- Appearance and fit: Bolts centred in slotted holes unless otherwise indicated. Joints free to move.

447 BONDED ANCHORS

- Holes: Clean and free from dust at time of installing anchor.
- Permeable sleeves: Use in conditions where otherwise the loss of bonding agent would be unacceptably high.
- Other requirements: refer to drawings.

TESTING

460 QUALITY CONTROL

- Arrange the tests in the following section for
  - Fabrication phases at shop.

  - Erection phases at site.
- Provide testing agency with access to places where structural steel works is being fabricated or produced or erected so required inspection and testing can be accomplished.

465 TESTING

- Testing: Arrange tests for each type of product indicated. Prepare test pieces as necessary.
- Product data: As detailed in clause “Information Submittals” For each type of product indicated.
- Test: Testing agency will:
  - Inspect and approve the received raw material and material delivered to site.
  - Conduct and interpret tests and state in each report whether test specimens comply with or deviate from requirements.
  - Review and approve steel fit up and dimension check report.
  - Inspect and approve the completed fabricated material prior to dispatch to site.
  - Review and approve steel alignment and survey reports.
  - Inspect and test all bolted and welded connections.
  - Inspect and approve the composite deck construction.
  - Inspect and approve surface rectification and application of any coating system including painting or fireproofing system.
  - Certify welders and conduct inspections and tests as required, Record types and locations of defects found in works, Record works required and performed to correct deficiencies.
  - Carry out ultrasonic testing for lamination. The appropriate through thickness tension properties (Z-Quality) material is to be utilized to diminish possibility of lamellar tearing and cracks.
  - Inspect and approved welded shear connector.
  - Test Non-shrink grout.
- Testing authority: Accredited laboratory or an approved laboratory.
  - The fabricator could be the testing authority if the necessary facilities, equipment and qualified personnel are available.
  - Or Testing authority: Contractor will engage at his own expenses a qualified independent testing and inspecting agency approved by owner’s designated representative for construction to perform shop and field inspections and tests and to prepare test reports for owner’s representative review and approval.
- Frequency/ Number: Where the extent of a test cannot be expressed as a frequency, a number, or provisional number can be inserted. Examples are as follows:
  - Visual inspection of all welds.
  - Non-destructive tests on 10% of fillet and partial penetration weld length of each joint as a first round, depending on its results the Engineer might instruct the Contractor to extend the testing process and/or to replace welder at no extra cost.
  - Non-destructive tests on 100% of the lengths of all complete joint penetration (full penetration) weld.
  - Non-destructive tests on 100% of site welds; Depending on its results, the Engineer might instruct the Contractor to replace welder at no extra cost. Non-destructive tests of complete joint penetration (full penetration butt weld) welds to be done on 100% of the welded lengths.

  - Lamination test on all head plates for moment connections with 15 mm thick and above.
  - Lamination test on plates with 25 mm thick and above, and plates subjected to through thickness tensile stresses.
  - Prepare 50 mm cubes of the non-shrink grout and test for compressive strength, a total of six test specimens shall be prepared, three of which will be tested.
- Level of acceptability: to be agreed; as per Specifications.
  - Contractor to correct deficiencies in or remove and replace structural steel that inspections and test reports indicate do not comply with specified requirements.
  - Additional testing, at Contractor's expense, will be performed to determine compliance of corrected works with specified requirements.
  - Testing agency may inspect structural steel at plant before shipment, however, Engineer reserves right, at any time before final acceptance, to reject material not complying with specified requirements.
  - Cracks or zones of incomplete fusion or penetration of welds are not acceptable.
- Other requirements:
  - Selection of tested samples to be approved by the Engineer.
  - Fillet weld to be tested in accordance to Liquid Penetrate Inspection, or Magnetic Particle Inspection performed on root pass and on finished weld of fillet welds at random;
  - Partial and Full Penetration Welds to be tested in accordance to Radiographic Inspection, or Ultrasonic Inspection;
  - Visual test on welded shear connectors, and bend test to be performed when visual inspections reveal either less than a 360-degree flash or welding repairs to any shear connector.
  - Tests to be conducted on additional shear connectors when weld fracture occurs on shear connector already tested.
  - In addition to visual inspection, test and inspect field-welded shear connectors for stud welding and as follows: Perform bend tests if visual inspections reveal either a less-than-continuous 360-degree flash or welding repairs to any shear connector. Conduct tests on additional shear connectors if weld fracture occurs on shear connectors already tested.
  - Plates and rolled members subject to tension vertical to the rolling direction as well as the requirement for welding of thick plates will require appropriate through thickness tension properties (“ttt”/“z-quality”) as per BS EN 1993-1-10 and BS EN 10164. Contractor is responsible, in accordance to his fabrication process, procedure and plates thickness, if Z quality plates are required in any other details to reduce the possibility of lamellar tearing occurrence.
- Test and examination results: Submit <five> copies immediately they are available; State compliance or non-compliance with specifications.

466 TESTS REFERENCE

- Visual Inspection to BS EN ISO 17637.
- Liquid Penetration Inspection to BS EN ISO 3452, and ASTM E165/E165M for American Standards.
- Magnetic Particle Inspection to BS EN ISO 17638, BS EN ISO 9934, and ASTM E709/E709M for American Standards.

- Radiographic Inspection to BS EN ISO 17636-1 and -2, BS EN ISO 5579, ASTM E94/E94M, minimum quality level "2-2T" for American Standards.
- Ultrasonic Inspection to BS EN ISO 17640, BS EN ISO 23279, BS EN ISO 11666, and ASTM E164/E164M for American Standards.
- Lamination inspection to in accordance with BS EN 10160, BS ISO 17577, ASTM E164, and ASTM A435/A435M for American Standards.
- Test methods for hot dip galvanized coatings to BS EN ISO 1461.
- Shear connector Inspection according to requirements in BS EN ISO 14555, BS EN ISO 13918, BS EN 1994-1-1, abd AWS D1.1/D1.1M for American Standards.
- Non-shrinkage grout to ASTM C109, or approved equal in EN Standards.

467 EXCEPTIONS TO NSSS CE MARKING VERSION REQUIREMENTS FOR WELD TESTING

- Weld location: as per drawings and approved calculations.
  - Requirements: Final acceptance of welds to BS EN 1090-2, Section 12.4.

470 SITE TESTING OF ANCHORS TO MASONRY

- Standard: To BS 5080.
- Preliminary tests: 5 No. tests for tensile loading to failure in locations that will be hidden in completed structure.
- Proof tests: Test 10% of working fixings to 1.5 times the working load
- Test results: Report failures and seek instructions.

COATING

700 PROTECTIVE COATINGS / PROTECTIVE COATING SYSTEMS / PREPARATION FOR PAINTING

- Refer to Architectural sections related to High performance coatings, Applied Fire Protection for requirements of cementitious fireproofing on steel, and Intumescent Fire Protection for requirements of intumescent fireproofing on steel. Painting and fire proofing shall be read from Section M22 for SPRAYED MONOLITHIC COATINGS, Section M60 for PAINTING AND CLEAR FINISHING, and Section M61 for Intumescent coatings for fire protection of steelwork

710 SURFACES NOT TO BE COATED

- Location: [as shown on drawing].

730 PREPARATIONS FOR SITE WELDING OF SHOP PAINTED STEELWORK

- Method:
  - Mask weld areas immediately after blast cleaning and before coating steelwork. If paint system comprises more than one coat, step each coat 30 mm back from edge of preceding coat and away from masked areas. Remove masking immediately before welding.
  - Prepare and paint steelwork including weld areas. Grind off to bare steel around each weld area immediately before welding.

735 TREATMENT OF SITE WELDED JOINTS IN PAINTED STEELWORK

- Preparation: After welding, and without delay, remove scale and weld spatter from weld areas. Remove traces of rust. Wash with clean water and allow to dry. Prime without delay.
- Protective/ Decorative coatings: Apply to weld areas to match surrounding painted areas.

736 TREATMENT OF SITE WELDED JOINTS IN GALVANIZED STEELWORK

- Preparation: After welding, and without delay, remove scale and weld spatter from weld areas. Remove traces of rust. Wash with clean water and allow to dry.
- Coating: Reinstate using one of the methods given in BS EN ISO 1461, clause 6.3.

740 BOLTED JOINTS (OTHER THAN PRELOADED JOINTS)

- Steelwork to be shop painted: Apply full shop specification to joint faces.
- Steelwork to be erected with mill finish then site painted: Before erection, prepare and prime joint faces and allow to dry.
- Bolted joints in externally exposed steelwork:
- Immediately before assembling, apply a further coat of primer and bring surfaces together while still wet.
- After assembling and before applying site coatings, seal crevices to bolts and joint perimeters with a compatible sealant.

745 FAYING SURFACES OF PRELOADED JOINTS

- Protection: Immediately after blast cleaning and before coating surrounding areas, mask faying surfaces to protect from contamination and deterioration.
- Paint systems comprising more than one coat: Step each coat 30 mm back from edge of preceding coat and away from masked areas.
- Removal of protection: Immediately before bolting, remove masking. Check faying surfaces are free from adhesive. Clean with solvent if necessary.

750 PRELOADED JOINTS IN SHOP PAINTED STEELWORK

- Post assembly treatment of bolts and surrounding areas: After final tightening of bolts and inspection of joints:
- Thoroughly degrease and clean uncoated areas including bolts.
- Prime without delay.
- Apply full shop coating specification.
- Direct tension indicators: Seal measuring gap to prevent ingress of moisture.

H41 GLASS FIBRE REINFORCED PLASTICS CLADDING/ FEATURES

To be read with Preliminaries/ General Conditions.

130 GRP PURPOSE MADE FEATURES GRP ladders

- Primary support structure: Concrete blockwork, as section F10 or as indicated on drawings.
- GRP components:
  - Manufacturer: Submit proposals to Engineer's approval.
  - Construction: Submit proposals to Engineer's approval.
  - Finish: Gloss.
  - Colour: to BS 4800.
  - Fire rating:
    Spread of flame (component external face): Index (1) not more than 20 (National class).
    Spread of flame (component internal face): As external face.
- Fixings and fasteners: Submit proposals to Engineer's approval.
- Joints: submit proposals to Engineer's approval.
- Accessories/ Other requirements:
  - Manufactured to BS EN ISO14122-3: 2001 and BS5395-1
  - The completed handrail installation shall meet the following load requirements with a minimum factor of safety of 2.0:
  - Concentrated Load: 891 N applied in any direction at the top rail.
  - Uniform Load: 730.5 N/m of the top rail in any direction.
- Loads are assumed not to act concurrently.

130A LADDER SYSTEM GRP LADDER WHERE INDICATED ON DRAWINGS

- Method of provision: Fabricated off site and assembled on site.
- Dimensions: As indicated on drawings.
- Basic component material: Isophthalic Polyester.
- Rungs: Solid bar 20mm dia.
- Stiles: pultruded glass reinforced polyester.
- Landings/ platforms: Not required.
- Hoops: Not required.
- Assembly connectors: Stainless steel bolt assemblies and Full welds, unless otherwise indicated on drawings.
- Fixing to superstructure: Stainless steel bolts and Expanding bolts as indicated on drawings.
- Accessories: Brackets for fall arrest system, as section N25 unless indicated otherwise on drawings.
- Phenolic (to BS 476, Part 7): Class 0.

DESIGN/ PERFORMANCE REQUIREMENTS

205A CONTRACTOR'S DESIGN OF GRP LADDERS

- Design responsibility: Determine sizes and thickness of units and type size, number and spacing of fixings.
- Structural and fire requirements:
  - Generally: As per structural specifications.
  - Modifications: None.
  - Design: Complete the design in accordance with the designated code of practice to satisfy specified performance criteria.
- Functional requirements: As specified in this section.

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- Additional requirements: None.
- Design and production information: As Preliminaries.
- Timing of submissions: As Preliminaries.

260 FIRE RATING CERTIFICATION

- Verification: Before commencing full manufacture, submit evidence based on laboratory testing.
- Testing authority: Civil defense authorities and authorities having jurisdiction.

270 COLOUR FASTNESS/ APPEARANCE OF GRP

- Colour fastness of pigments: Not less than standard 6 when measured to BS 1006:B01C:LFS6.
  - Evidence of compliance: Submit.

275 COLOUR FASTNESS/ APPEARANCE SAMPLES

- Weathered samples: If available, submit naturally weathered samples, otherwise submit artificially weathered samples.
- Naturally weathered samples:
  - Pigments and resins: As proposed GRP.
  - Age: Not less than two years.
  - Action: Submit with new unweathered control samples.
- Artificially weathered samples:
  - Pigments, resins and gel coat: As proposed GRP.
  - Test method: Accelerated weatherometer subjecting samples to moisture and ultraviolet light.
  - Duration: Not less than 1500 hours.
  - Action: Submit with new unweathered control samples.

320 DESIGN SAMPLES

- GRP samples: Before general manufacture obtain approval of appearance of fully tested compliant design samples of: Each component type as indicated on drawings.
  - Extent: Showing proposed colour, texture and incorporating a completed section of a joint.
  - Action: Obtain approval of appearance before proceeding. Retain as production control sample.

330 MOCK-UP

- Element: At an agreed stage during detailed design construct a mock-up of: all types as directed by Engineer.
- Function: To refine design details.
- Inspection: Obtain approval of appearance before proceeding. Retain mock-up in undisturbed condition until completion of GRP installation.

MANUFACTURE

410 QUALITY OF WORK

- Manufacture: Compliant with design and performance requirements.
  - Materials: Appropriate and compatible.
  - Workmanship: Appropriate and in accordance with manufacturers' recommendations.
- Resins: Used as supplied and not adulterated.
- Fillers and admixtures: Submit proposals.
- Standard of finish: Appropriate to end use and position in building.
  - Prohibited blemishes: Including, but not limited to, wrinkling, spotting, striations, fibre patterning, fish eyes, blisters, crazing, cracking, dry patches and uneven or inconsistent colour.

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440 MANUFACTURING ACCURACY

- Finished dimensions of completed units when erected:
  - Ambient temperature: Measurements taken at 16-18°C.
  - Maximum permissible deviations:

Overall dimension involved (m)	Up to 2	2-3	3-4.5	4.5-6
Width and height:	+0 -2 mm	+0 -3 mm	+0 -5 mm	+0 -6 mm
Straightness of edges: deviation from intended line, any variation to be evenly distributed with no sudden bends or irregularities.	3 mm	4 mm	5 mm	6 mm
Squareness: taking the longer of 2 sides at any corner as a base line, the deviation of shorter side from perpendicular; dimension involved is the shorter side.	3 mm	4 mm	5 mm	6 mm
Twist: deviation of any corner from the plane containing the other 3 corners; dimension involved is the shorter side.	3 mm	5 mm	7 mm	8 mm

Flatness - deviation under a 1 m straight edge placed anywhere on a flat panel surface: 3 mm

470 BONDING OF CONSTITUENTS

- Resin layers: Good overall bond between gel coats and layers of laminate.
- Additional components: Core materials, ties, ribs, fixings and accessories fully bonded to GRP skins over full contact surface area.

480 FIXINGS AND FASTENERS

- Loadbearing fixing type: Submit proposals to Engineer's approval.
  - Material: Austenitic stainless steel grade 1,4401 (316).
- Restraint fixing type: Submit proposals to Engineer's approval.
  - Material: Austenitic stainless steel grade 1,4401 (316).
- Extent of adjustment: To accommodate support structure/ cladding fabrication/ installation tolerances and thermal movement of GRP.
- Method of fixing to primary support structure: Submit proposals to Engineer's approval.
  - Avoidance of bimetallic corrosion: Select appropriate materials for fixings/ fasteners/ spacers/ washers.

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490 SEALING OF UNITS

- Flow coat: Apply to all surfaces of finished units which are not gel coated.
- Cut edges and holes: Seal to avoid penetration of moisture into glass fibres.

500 CURING

- Initial curing period at 20°C: 24 hours.
- Oven curing regime: As product data sheet.
- Distortion during curing: Prevent.

505 METAL POWDER FINISH

- Polishing: Remove an even film of resin to ensure natural patination of the whole exposed surface.

510 HARDNESS TESTING

- Standard: To BS EN 59.
- Timing: After curing.
- Extent: One test for each 1 m² of external surface area, not less than 2 tests per unit. The number of measurements shall be such that the average result has a standard deviation of +4%.
- Barcol hardness at ambient temperature: Not less than 30.

530 WEIGHT TESTING

- First unit of each type and size:
  - Compliance: In accordance with design and specification.
  - Weight: Record.
- Subsequent units:
  - Acceptable weight: Unmodified subsequent units to be within 10% of weight of first unit.

560 ADDITIONAL UNITS FOR DESTRUCTIVE TESTING

- Unit type: Component to Engineer's approval.
  - Additional quantity: as selected by Engineer.
- Testing: Permit random selection of units.

570 PRODUCTION RECORDS

- Recorded information:
  - Unique identification number.
  - Full details of composition.
  - Date of each stage of manufacture.
  - Dates and results of tests, checks and inspections.
  - Dimensions related to specified levels of accuracy.
  - Specific location in the finished work.
  - Other pertinent data, e.g. if the unit is a production control unit.
- Availability of records: For inspection on request.

580 RETENTION OF MOULDS AFTER PRODUCTION

- Purpose: Retain moulds and store in a reusable condition to allow manufacturing to recommence if required.
- Retention period: Until completion.

INSTALLATION

605 PREPARATION

- Prefabrication: Complete products and attach fixings in workshop wherever possible.
- Identification: Mark or tag products. Do not mark surfaces visible in the complete installation.

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- Electrolytic corrosion: Isolate dissimilar metals.

635 ACCURACY OF ERECTION OF GRP COMPONENTS

- Joint widths: Within joint lengths, including in-line continuations across transverse joints, as follows:
  - Tolerance: Greatest width not to exceed least width by more than 20%.
  - Variations: Evenly distribute, with no sudden changes.
- Offset in elevation: Between component edges across transverse joints not to exceed 10% width of joint.
- Offset in plan or section: Between flat faces of adjacent units across joints not to exceed 10% width of joint.
- Sealant joints width limitations: To recommendations of sealant manufacturer.
- Finished work: True to line and plane with satisfactory fit at junctions.

640 FINAL FIXING

- Torque figures: Tighten threaded fastenings to figures recommended by manufacturer. Do not overtighten restraint fixings intended to permit lateral movement.

645 METALWORK

- Material standards and fabrication: As section Z11.

650 SEALANT JOINTING SYSTEM

- Sealant: Silicone.
  - Class to BS EN ISO 11600: F-20LM.
  - Colour: To be agreed.
  - Other requirements: To be agreed.
- Joint back up/ filler: Closed cell plastics foam (minimum 25% compression in joint).
- Primer: As recommended by sealant manufacturer.
- Application: As section Z22.

680 CLEANING DOWN

- General: Return to site at completion or when instructed and thoroughly clean down the entire area of the GRP work. Cleaning agents for the purpose must be approved by the GRP manufacturer.

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J10 CEMENTITIOUS MORTAR TANKING/ DAMP PROOFING

To be read with Preliminaries/ General Conditions.

TYPES OF TANKING/ DAMP PROOFING

111 POLYMER MODIFIED CEMENTITIOUS WATERPROOFING TO WET AREAS UNDER TILES WATERPROOFING AND WHERE INDICATED

- Substrate: Concrete.
- Manufacturer: Submit proposals.
  - Product reference: Agreement certified system and Submit proposals.
- Coats (excluding dubbing out):
  - Number (excluding keying mixes): Two and as coating manufacturer's recommendations.
  - Thickness: 2 mm and as coating manufacturer's recommendations.
- Finish: as shown on drawings and as waterproof coating manufacturer's recommendations.
- Other requirements: Movement joints.
- Features:
  - Positive-Negative Side, Polymer-Modified Cement microfiber reinforced class A4 crack bridging Waterproofing coating for concrete substrates performance in accordance with BS EN 14891.
  - Product shall be classified CMO2P based on BS EN 14891 and shall meet EN 1504-2 requirements.
  - Manufacturer's proprietary blend of dry cementitious and other ingredients for mixing with polymer admixture to produce a waterproof coating that is suitable for vertical and horizontal applications below or above grade, is breathable, resists positive-side hydrostatic pressure, and has properties complying with or exceeding the criteria specified below.
- Technical Characteristics:
  - Impermeability to water under pressure (150 Kpa for 7days): To EN 14891-A.7: no penetration.
  - Crack bridging ability at 23 degrees Celsius: To EN 14891-A.8.2 not less than 2.5 mm.
  - Crack bridging ability at -5 degrees Celsius: To EN 14891-A.8.3 not less than 0.75 mm.
  - Initial adhesion strength (MPa): To EN 14891-A.6.2 not less than 1.
  - Tensile adhesion strength after water contact (MPa): To EN 14891-A.6.3, not less than 0.6.
  - Tensile adhesion strength after heat aging (MPa): To EN 14891-A.6.5, not less than 1.2.
  - Tensile adhesion strength after freeze-thaw cycle (MPa): To EN 14891-A.6.6, not less than 0.65
  - Tensile adhesion strength after immersion in basic water (MPa): To EN 14891-A.6.9, not less than 0.65.
  - Tensile adhesion strength after immersion in chlorinated water (MPa): to EN 14891-A6.8, not less than 0.65.
  - Product shall be tested and certified for suitability in potable water applications where applicable, including use in potable water storage tanks, in accordance with NSF/ANSI 61, BS 6920, or applicable equivalent standard.
  - For applications in cold climate areas where temperatures may reach less than -5 degrees Celsius, product crack bridging ability shall be tested according to EN 14891-A.8.3 at -20 degrees Celsius with minimum result of 0.75 mm.
  - Color: As approved by Engineer.

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- Warranty:
  - Special Warranty: Written warranty, signed by the Applicator and countersigned by the Contractor agreeing to repair or replace waterproofing that does not comply with requirements or that fails to perform as required, and to maintain watertight conditions within specified warranty period. Warranty includes responsibility for removing and replacing other work that conceals modified cement waterproofing. During warranty period, repairs and replacements required because of unusual weather phenomena and other events beyond the Contractor's or the Applicator's control shall be completed by the Contractor or the Applicator and paid for by the Employer at prevailing rates.
  - Warranty Period: 10 years from date of Substantial Completion.

MATERIALS AND MAKING OF MORTAR

330 MOVEMENT JOINT SYSTEM

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
  - Application: As section Z22.

340 SEALANTS AROUND SERVICE PENETRATIONS, ALONG WALL-TO-FLOOR ABUTMENTS AND WHERE INDICATED ON DRAWINGS

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Colour: To match surface finish and as selected by Engineer.
  - Application: As section Z22.

PREPARING SUBSTRATES

410 SUITABILITY OF SUBSTRATES

- Preparation generally: To tanking mortar/ admixture manufacturer’s recommendations.
- Stability and soundness: Free from movement, and loose or weak areas that will cause failure of tanking.
- Key: To achieve firm adhesion of tanking.
- Contamination: Free from previous coatings and contaminants including dirt, dust, efflorescence, mould, oil, paint and plaster.
- Cracks, porous patches and other defective areas subject to water pressure and liable to admit water: Control and seal using waterproof mortar recommended by the tanking mortar manufacturer.
- Holes/ Recesses for fixings (where permitted): Prepared to receive fasteners.
- Openings and chases: Prepared, including sleeves for pipe penetrations and chases to receive waterproofing compounds/ sealants.

420 PREPARATION OF MORTAR JOINTS AND CAVITIES

- Mortar joints: Rake out to a depth of 12 mm (minimum).
  - Debris: Remove and flush out with water.
  - Fill: Repoint with waterproof mortar to the tanking mortar manufacturer's recommendations.
- Blow holes, cavities, cracks, etc: Remove loose material and fill flush using waterproof mortar recommended by the tanking mortar manufacturer.

430 TANKING INTEGRITY

- Penetrations for fixings, services, etc: Permitted for bolt fixings using coating manufacturer's recommended methods.

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EXECUTION

510 APPLICATION GENERALLY

- Application methods and coating sequence: As recommended by the tanking mortar/ admixture manufacturer to achieve a water-resistant structure.

520 JOINTS/ JUNCTIONS AND PENETRATIONS

- Abutments, joints and active cracks: Sealed and watertight.
  - Movement joints: Centred over joints in substrate and extended through waterproof coating and finishes.
  - Daywork joints in successive coatings: Staggered and lapped.
  - Angled joints: Not permitted.
- Penetrations: Watertight.

530 APPEARANCE OF TANKING

- Render/ Screed coatings: Even and consistent. Free from rippling, hollows, ridges, cracks and crazing.
  - Accuracy: A true plane, to correct line and level. Walls and reveals plumb and square with neat arises
- Thin slurry coatings: Consistent and free from hollows, cracks and crazing. Suitable to receive specified finish.

540 FLATNESS/ SURFACE REGULARITY OF TANKING SCREEDS

- Measurement method: From the underside of a 3 m straightedge (between points of contact) placed anywhere on surface and using a slip gauge to BS 8204-1 or -2 (or equivalent).
- Deviation of surface: Sudden irregularities not permitted.
  - Maximum permissible deviation: 1 mm under 1 m straightedge.

550 CURING AND DRYING

- General: Prevent premature setting, uneven drying and cracking of each coat.
- Curing coatings: Prevent evaporation from surface.
  - Curing period (minimum): As the cementitious waterproof coating manufacturer's recommendations.

560 PROTECTION

- Mechanical damage: Prevent impact and abrasion.
- Application of protective coatings/ linings: After completion of curing.

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J30A - LIQUID APPLIED TANKING/ DAMP PROOFING

To be read with the structural drawings and structural basis of design report.

TYPES OF TANKING/ DAMP PROOFING

100 WARRANTY

- Manufacturer's Warranty: Provide written Warranty, signed by Damp proofing Manufacturer and Installer, and countersigned by Contractor, agreeing to replace damp proofing material that does not comply with requirements during specified Warranty period. Warranty includes responsibility for removing and replacing construction and other Works that conceal damp proofing. Warranty period shall be for 10 years.

110 COLD APPLIED TANKING TO SURFACES IN CONTACT WITH SOIL

- Substrate: In situ concrete structural elements in contact with soil other than basement walls.
- Primer: as per approved system recommendations.
- Coating: Bituminous.
  - Manufacturer: Submit proposals.
    Product reference: for tanking to prevent infiltration of subsurface water under pressure.
  - Application: as per approved system.; Two coats; first coat 0.75 kg/m², second coat 1 kg/m²; Floors; first coat 1.0 L/m², second coat 0.75 L/m².
- Reinforcement: As per coating manufacturer's recommendations.

120 COLD APPLIED TANKING TO INTERNAL SURFACES OF WATER RETAINING STRUCTURES.

- Substrate: reinforced concrete surfaces.
- Primer: as per approved system recommendations.
- Coating: Crystalline coating
  - Manufacturer: Submit proposals.
    Product reference: surface-applied material that causes capillary waterproofing system to protect concrete in-depth. Pre-packaged white - Colored proprietary blend of Portland cement, specially treated sand, and active chemicals that, when mixed with water and applied, penetrates into concrete and reacts chemically with the products of cement hydration in the presence of water to develop crystalline growth within substrate capillaries to produce an impervious, dense, waterproof substrate.
  - Application: as per approved system.
- Reinforcement: As per coating manufacturer's recommendations
- Accessories materials:
  - Patching compound: Ready mixed cementitious waterproofing and repair mortar for filling and patching tie holes, honeycombs, reveals, and other imperfections.
    Compressive strength: minimum 30MPa at 28 days when tested according to BS 6319-2.
    Flexural strength: Minimum 5MPa at 28 days when tested according to BS 6319-3.
    Shrinkage: Minus 0.01 percent at 28 days and plus 0.07 percent at 90 days when tested according to ASTM C596.
  - Plugging compound: Cementitious, ready mixed, efflorescence-free, surface waterproofing compound with hydrophobic properties that requires only the addition of water, and is resistant to water and moisture but is vapor permeable for all standard applications (vertical, overhead and horizontal surfaces not exposed to vehicular traffic); with properties meeting or exceeding the following criteria:
    Permeability: less than 5mm according to DIN 1048-5.

Compressive strength: Minimum 30MPa at 28days when tested according to BS 6319-2.
Flexural strength: Minimum 5MPa at 28days when tested according to BS 6319-3.
Bond strength: 2MPa at 14days when tested according to BS EN 12504-3.

- Mixes: Add pre-packaged dry ingredients to water according to Manufacturer's written instructions. Mix together with mechanical mixer or by hand to required consistency.

EXECUTION

205 SUITABILITY OF SUBSTRATE

- Substrates generally:
  - Smooth, even textured, clean, dry and frost free.
  - Within tolerances for level and surface regularity.
  - Vertical and horizontal surfaces: Correctly prepared and free from irregularities.
- Examine Substrates, areas, and conditions with Applicator present, for compliance with requirements for surface smoothness and other conditions affecting performance of Works.
- Curing period for concrete substrates (minimum): 7 days.
- Moisture content and stability of substrate: Must not impair integrity of finished tanking/ damp proofing**.**
- Preliminary work: Complete including**:**
  - Chases.
  - External angles.
  - Formation of upstands and kerbs.
  - Movement joints.
  - Penetrations/ Outlets.
- Proceed with application only after substrate construction and penetrating Works have been completed and unsatisfactory conditions have been corrected.

206 ADHESION TESTING

- Tensile bond strength: Test in accordance with BS EN ISO 4624**.**
- Test results: Submit.

207 PRIMERS

- Application: Uniform, continuous coverage.

210 COATING APPLICATION

- Adjacent surfaces exposed to view in finished work: Protect**.**
- Coatings:
  - Apply in dry atmospheric conditions when substrate is dry. Refer to approved coating requirements.
  - Uniform, continuous coverage. Do not allow to pool in hollows.
  - Firmly adhered to substrate and free from imperfections.
  - Prevent damage to finished coatings.
- Where damp proofing footings and foundation walls, apply from finished grade line to top of footing. Extend over top of footing and down a minimum of 150mm over outside face of footing.
  - Extend onto blinding beds, intersecting walls and footings, but do not extend onto surfaces exposed to view when Project is completed, unless otherwise indicated.
  - Install flashings and corner protection stripping at internal and external corners, changes in plane, construction joints, and cracks.

- Where damp proofing exterior face of inner wythe of exterior masonry cavity walls, lap damp proofing at least 6mm onto flashing, masonry reinforcement, veneer ties, and other items that penetrate inner wythe.

  - Extend damp proofing over outer face of structural members and concrete slabs that interrupt inner wythe.
  - Lap damp proofing at least 6mm onto shelf angles supporting veneer.
- Where damp proofing interior face of above grade, exterior concrete and masonry single wythe masonry walls, continue damp proofing through intersecting walls by keeping vertical mortar joints at intersection temporarily open or by damp proofing wall before constructing intersecting walls.
- Penetrations: impervious.
- Final covering: Apply as soon as possible after coating has hardened.

220 COLD APPLIED COATINGS – RUBBERIZED BITUMEN EMULSION; EMULSIFIED ASPHALT DAMP PROOFING

- Thinning: Not permitted unless recommended by manufacturer.
- Successive coats:
  - Allow to dry before applying next.
  - Apply at right angles to previous.

221 COLD APPLIED COATINGS – CRYSTALLINE WATERPROOFING

- Preparation and application:
  - Comply with Manufacturer's written instructions.
  - Protect other Works from dripping or splatter from crystalline waterproofing during application. Provide temporary enclosure to confine operation, to prevent polluting the air, and to ensure adequate ambient temperatures and ventilation conditions for application.
  - Do not allow waterproofing, patching, and plugging materials to enter reveals or annular spaces intended for resilient sealants or gaskets, such as joint spaces between pipes and pipe sleeves.
  - Stop active water leaks with plugging and patching compounds according to waterproofing Manufacturer's written instructions.
  - Repair damaged or unsatisfactory substrate with patching compound.
  - Saturate surface with water for several hours and maintain damp condition until applying water proofing. Remove standing water.
  - Apply waterproofing to surfaces, and extend waterproofing onto adjacent surfaces as follows:
    - Onto columns integral with treated walls.
    - Onto interior non-treated walls intersecting exterior treated walls, for a distance of 600mm for cast-in-place concrete.
    - Onto exterior walls and onto both exterior and interior columns, for a height of 300mm, where floors, but not walls, are treated.
    - Onto every substrate in areas indicated for treatment, including pipe trenches, pipe chases, pits, sumps and similar offsets and features.
- Curing: cure waterproofing immediately after coat has set, as recommended by Manufacturer.

230 BITUMINOUS COATINGS

- Air and surface temperatures (minimum): 5°C.
- Weather conditions: Do not apply if there is a risk of rain during application and drying unless effective temporary cover is provided over working area.
  - Unavoidable wetting of construction or coatings: Minimize and make good damage.

235 MODIFIED COATINGS

- Air and surface temperatures: Do not apply if below minimum recommended by coating manufacturer.

- Curing: Keep dry until fully cured.

COMPLETION

310 INSPECTION
- Interim and final inspections: Submit reports.

320 ELECTRONIC INTEGRITY TEST
- Testing authority: The coating contractor.
- Timing of test: Prior to placement of protection boards and backfilling.
- Condition of coating prior to testing:
  - Complete to a stage where integrity can be tested.
  - Surface: Clean.
- Test results and waterproof integrity certificate: Submit on completion of testing.

330 PROTECTION OF EXTERNAL COATINGS
- Coated surface: Clean and free from contaminants.
- Board manufacturer: Submit proposals.
  - Product reference: submit proposals.
  - Thickness: as per approved manufacturer's requirement.
- Placement: as per approved board protection requirement.
  - Edges: as per approved system requirements.
  - Perimeter treatment: as per board protection requirements..
- Contact with coating: Secure and continuous**.**

340 BACKFILLING TO EXTERNAL COATINGS
- Timing: Carry out as soon as possible after tanking and protection are complete.

J30 B LIQUID APPLIED TANKING/ DAMP PROOFING

To be read with Preliminaries/General Conditions.

TYPES OF TANKING/ DAMP PROOFING

130A COLD FLUID APPLIED WATERPROOFING WHERE INDICATED

- Substrate: smooth in situ concrete slab unless otherwise indicated on drawings.
- Primer: As coating manufacturer's recommendations.
- Coating: a single part, rapid curing, modified polyurethane waterproofing membrane that can be applied directly to concrete surfaces.
  - Manufacturer: Contractor's choice.
    Product reference: Contractor's choice.
  - Application: As coating manufacturer's recommendations.
  - Components: urethane primer to cementitious and porous surfaces. Coverage per coat: 8 sq.m/litre. Topcoat: cold applied UV resistant polyurethane coating.
  - Protection Mat: nonwoven geotextile, polypropylene fabric; water permeable and resistant to UV degradation; type and weight as recommended by roofing system manufacturers for application but not less than 200 g/m2 mass per unit area, and minimum static puncture resistance of 2 Kn.
    Blinding: As coating manufacturer's recommendations.

- Minimum physical and performance requirements as determined by laboratory testing:

  - Solid Content by volume: Not less than 80 percent when tested to ASTM D2697.
  - Tensile strength: Not less than 2 MPa when tested to ASTM D412.
  - Elongation: Not less than 500 percent when tested to ASTM D2370.
  - Water Vapor Permeance: Maximum 0.1 perm (5.7 ng/Pa x s x sq. M), when tested to ASTM E96/E96M.
  - Hardness, type OO to ASTM D2240: Not less than 85.
  - Low Temperature Crack Bridging: Pass result when tested to ASTM C1305.
  - Adhesion in peel: Not less than 2 MPa when tested to ASTM D4541.
  - Extensibility after heat aging: Should pass and show no observable cracking after minimum 6.4 mm extensibility when tested to ASTM C1522.
  - UV resistant for exposed applications: Pass result for 2000 hrs.
  - Root penetration: Resistant when tested to CEN/TS 14416 where applicable and required by Engineer.
  - Product shall be tested and certified for suitability in potable water applications where applicable and required by Engineer, including use in potable water storage tanks, in accordance with NSF/ANSI 61, BS 6920, or applicable equivalent standard.

- Compatibility: Provide waterproofing system materials suitable for the location and intended application, that are compatible with one another and with adjacent materials under conditions of service and application required, as demonstrated by waterproofing manufacturer based on testing and field experience.

130D EPOXY WATERPROOFING

- Substrate: smooth in situ concrete slab unless otherwise indicated on drawings.
- Primer: As coating manufacturer's recommendations.

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- Epoxy waterproofing, two components, non-toxic, solvent free epoxy resin based, flexible protective coating which provides a waterproof and chemical resistant surface for concrete and metal substrates, applied to concrete or metal potable water tanks and where indicated by Engineer:

  - Adhesion to concrete: Not less than 1.5 MPa when tested to ASTM C4541.
  - Water penetration under pressure: Impermeable at 5 bars pressure when tested to DIN 1048-5 or equivalent applicable standard.
  - Product shall be tested and certified for suitability in potable water applications where applicable and required by Engineer, including use in potable water storage tanks, in accordance with NSF/ANSI 61, BS 6920, or applicable equivalent standard.
  - Protection Mat: nonwoven geotextile, polypropylene fabric; water permeable and resistant to UV degradation; type and weight as recommended by roofing system manufacturers for application but not less than 200 g/m2 mass per unit area, and minimum static puncture resistance of 2 Kn.
  - Blinding: As coating manufacturer's recommendations.

130E WARRANTY

- Full System Warranty: Provide full system warranty in which Manufacturer and Installer will repair without limitations, all or any part of the liquid waterproofing system which fails or becomes defective in materials or workmanship within specified warranty period.

  - Warranty includes removing and reinstalling protection board, drainage panels, insulation, pedestals, and pedestal-mounted pavers on plaza decks, due to failure. Failure includes, but not limited to water penetration, deterioration in membranes and coatings; other than due to normal aging and weathering; and any defects in insulation, protection board, drainage panels, pedestals, and pedestal-mounted pavers on plaza decks, coverings and other components of the work.
  - Warranty pavers do not dish or warp and do not crack, split, or disintegrate in freeze-thaw conditions.
  - Warranty Period: Ten (10) years from date of Substantial Completion.

EXECUTION

205 SUITABILITY OF SUBSTRATE

- Substrates generally:
  - Smooth, even textured, clean, dry and frost free.
  - Within tolerances for level and surface regularity.
  - Vertical and horizontal surfaces: Correctly prepared and free from irregularities.
- Curing period for concrete substrates (minimum): 7 days.
- Moisture content and stability of substrate: Must not impair integrity of finished tanking/ damp proofing.
- Preliminary work: Complete including:
  - Chases.
  - External angles.
  - Formation of upstands and kerbs.
  - Movement joints.
  - Penetrations/ Outlets.

206 ADHESION TESTING

- Tensile bond strength: Test in accordance with BS EN ISO 4624.
- Test results: Submit.

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207 PRIMERS

- Application: Uniform, continuous coverage.

210 COATING APPLICATION

- Adjacent surfaces exposed to view in finished work: Protect.
- Coatings:
  - Apply in dry atmospheric conditions when primer is dry.
  - Uniform, continuous coverage. Do not allow to pool in hollows.
  - Firmly adhered to substrate and free from imperfections.
  - Prevent damage to finished coatings.
- Penetrations: Impervious.
- Final covering: Apply as soon as possible after coating has hardened.

220 COLD APPLIED COATINGS

- Thinning: Not permitted unless recommended by manufacturer.
- Successive coats:
  - Allow to dry before applying next.
  - Apply at right angles to previous.

235 MODIFIED COATINGS

- Air and surface temperatures: Do not apply if below minimum recommended by coating manufacturer.
- Curing: Keep dry until fully cured.

240 REINFORCEMENT

- Laying: Laid into second coat with third coating applied locally over fabric.
- Edge overlap (minimum): 75 mm
- Finish: Smooth and free from imperfections.

260 JUNCTIONS WITH DPCS

- DPCS: Clean, all edges fully exposed.
- Application: Fully coat DPC and overlap adjacent surfaces by (minimum) 75 mm.

270 BLINDING

- Coatings: Blind whilst tacky.
- Surplus material: Remove when coatings are completely dry.

COMPLETION

310 INSPECTION

- Interim and final inspections: Submit reports.

320 ELECTRONIC INTEGRITY TEST

- Testing authority: approved laboratory.
- Timing of test: Give notice.
- Condition of coating prior to testing:
  Complete to a stage where integrity can be tested.
  Surface: Clean.
- Test results and waterproof integrity certificate: Submit on completion of testing.

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J40 - FLEXIBLE SHEET WATERPROOFING/ DAMP PROOFING

To be read with Preliminaries/ General Requirements.

100 WARRANTY

- Manufacturer's Warranty: Provide written Warranty, signed by waterproofing Manufacturer and Installer, and countersigned by Contractor, agreeing to replace waterproofing material that does not comply with requirements or that does not remain watertight during specified Warranty period. Warranty includes responsibility for removing and replacing construction and other Works that conceal waterproofing sheet. Warranty period shall be for 10 years.
- Installer special Warranty: Written waterproofing Installer's Warranty, signed by Installer, covering Works of this Section, for Warranty period of two years from taking over.
- Special Warranty: Submit a written Warranty signed and guaranteed jointly and severally by the Main Contractor, the Waterproofing Manufacturer and the Prefabricator/Applicator/Installer agreeing to repair or replace waterproofing that does not meet requirements or that does not remain watertight during the specified Warranty period. Warranty includes responsibility for construction remedial measures and for other works that conceal defective sheet waterproofing, and repair corresponding damages. Warranty does not include failure of waterproofing due to failure of substrate prepared and treated in accordance with requirements or formation of new joints and cracks in substrate exceeding 2.0mm in width. Warranty does not include mechanical damages to membrane created by other than Contractor, or his Sub-contractor after handing over of Project.

115 CONCRETE BLINDING TO HARDCORE BEDS

- Concrete: plain concrete as per section E10.
  - Thickness: see drawing.
- Finish on completion: Smooth.

TYPES OF TANKING/ DAMP PROOFING

297B WATERPROOFING/ DAMP PROOFING MEMBRANE

- Substrate: **[Concrete].**
- Manufacturer: Submit proposals.
  - Product reference: Self-Adhesive High Density Polyethylene Sheet, cold applied, flexible, preformed waterproofing membrane combining a special high performance cross laminated, high density multi-layer polyethylene film with a self-adhesive rubber/bitumen compound, BBA certified, Agrément certified**.**
- Number of layers: One**.**
  - Thickness/ Gauge: 1.5 mm**.**
- Bonding: Full adhesive bond**.**
- Joints:
  - Surfaces to be joined: Clean and dry beyond full width of joint**.**
  - Laps (minimum): as per approved membrane requirements**.**
  - Sealing: Fully adhere**.**
- Accessories: as per approved membrane requirements**.**

WORKMANSHIP

310 WORKMANSHIP GENERALLY

- Condition of substrate:
  - Clean and even textured, free from voids and sharp protrusions.
  - Moisture content: Compatible with damp proofing/ tanking.

- Air and surface temperature: Do not apply sheets if below is minimum recommended by membrane manufacturer.
- Condition of membrane at completion:
  - Neat, smooth and fully supported, dressed well into abutments and around intrusions.
  - Completely impervious and continuous.
  - Undamaged. Prevent puncturing during following work.
- Permanent overlying construction: Cover membrane as soon as possible.

320 INSPECTION
- Give notice: Before covering any part of membrane with overlying construction.

335 PRIMERS
- Manufacturer: Submit proposals.
  - Product reference: where required for waterproofing/ damp proofing system.
- Coverage per coat (minimum): as per approved system requirement.
- Curing: Allow to dry thoroughly before covering.

345 COLD APPLIED BONDING COMPOUNDS
- Type and application: As recommended for the purpose by the membrane manufacturer.

350 ANGLES IN BONDED DAMP PROOFING/ TANKING
- Preformed rot proof fillet to internal angles:
  - Size (minimum): 50 x 50 mm, splay faced.
  - Bedding: Bitumen mastic or bonding compound.
- Reinforcing strip to all angles:
  - Material: As damp proofing tanking.
  - Width (minimum): 300 mm.
  - Timing: Apply before main sheeting.
- Dressing of main sheeting onto adjacent surfaces (minimum): 100 mm.

360 JUNCTIONS WITH PROJECTING DPCS/ CAVITY TRAYS
- Adjoining surfaces: Clean and dry.
- Damp proof coatings/ Cavity trays: Lap and fully bond/ seal with sheeting.
  - Laps (minimum): As recommended for the purpose by the approved membrane manufacturer
  - Bonding/ Sealing: As recommended by the approved membrane manufacturer.

365 JUNCTIONS WITH FLUSH DPCS/ CAVITY TRAYS
- Adjoining surfaces: Clean and dry.
- Damp proof coatings / Cavity trays:
  - Expose edge where concealed.
  - Lap and fully bond/ seal sheeting to wall.
  - Dressing of sheeting beyond damp-proof coating/ cavity tray (minimum): 50 mm.
  - Bonding/ Sealing: As recommended by the approved membrane manufacturer.

370 PREFORMED COLLARS FOR PIPES, DUCTS, CABLES, ETC**.**
- Manufacturer: Submit proposals.
  - Product reference: where required.
- Sealing: As recommended by the approved membrane manufacturer.
- Completed junctions: Impervious.

380 PROTECTION BOARDS FOR DAMP PROOFING/ TANKING
- Manufacturer: Submit proposals.

  - Product reference: as required above.
- Thickness: As recommended by the approved membrane manufacturer and the protection board manufacturer.
- Application: Membrane surface clean and free from contaminants.
  - Bonding: As recommended by the approved membrane and protection board manufacturers.
  - Board joints: As recommended by the approved membrane and protection board manufacturers.
  - Board contact with membrane: Secure and continuous.
- Backfilling: Carry out when testing, tanking, loading and protection are complete.

J42 SINGLE LAYER POLYMERIC SHEET ROOF COVERINGS

To be read with Preliminaries/ General Conditions.

TYPES OF ROOF COVERING

120 INVERTED ROOF COVERING GENERALLY

- Substrate: Cement: sand screed.
  - Preparation: Cement: sand screed as section M10, laid to falls.
- Roof covering system: Manufacturer's recommended system complying with indicative drawings.
  - Protection layer (loose laid): Polyester fleece where indicated for roof garden system.
  - Waterproof membrane: fully adhered Ethylene propylene diene monomer (EPDM).
    Width: manufacturer's standard width as indicated on drawings.
    Thickness: 1.52 mm where indicated on drawings. Minimum thickness of 2.3 mm to be utilized for roof garden inverted system and where indicated on drawings.
    Colour: Black, unless othewise indicated.
  - Separating layer (loose laid): Nonwoven geotextile, polypropylene fabric; not less than 200g/m2 mass per unit area, and minimum static puncture resistance of 2Kn.
  - Insulation: Extruded polystyrene boards thickness to achieve the required thermal U value.
- Surface protection: Precast concrete paving slabs or crushed stone where indicated on drawings.
- Accessories: Determined by contractor to complete the system in accordance with manufacturer's recommendations and drawing details.

PERFORMANCE

202 CONTRACTOR'S DESIGN OF ROOF COVERINGS

- Design responsibility: Determine sizes, spacings and locations of fixings to suit the layout and details shown on drawing and submitted to Engineer's approval.
- Structural and fire requirements:
  - Generally: As section B50.
  - Modifications: None.
  - Design: Complete the design in accordance with the designated code of practice to satisfy specified performance criteria.
- Functional requirements:
  - Performance: As specified in this section.
- Additional requirements: None.
- Design and production information: As Preliminaries.
- Timing of submissions: As Preliminaries.

210A ROOF PERFORMANCE

- Roof covering: Secure, free draining and weathertight.
- Roof Assembly Overall Heat Transfer coefficient (U-value): roof assembly shall be not more than 0.25 W/m2. K, unless otherwise indicated
- Warranty: Provide complete system warranty in which Manufacturer and Installer are jointly and severally responsible and agree to repair or replace without limitations, all or any part of the membrane waterproofing system which fails or becomes defective in materials or workmanship within specified warranty period. Failure includes but is not limited to water penetration, deterioration in membranes; other than due to normal ageing and weathering; and any defects in adhesion, sealants, flashings, fixings, coverings and other components of the work.
  Warranty includes roofing membrane, base flashings, roofing membrane accessories, roof insulation, fasteners, drainage boards, roof pavers, and other components of membrane roofing system.

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Warranty Period: 20 years from date of Substantial Completion.

225 AVOIDANCE OF INTERSTITIAL CONDENSATION: WARM AND INVERTED ROOFS

- Interstitial condensation within roof construction: Determine risk as recommended in BS 5250 and BS EN ISO 13788.
- Vapour control layer: If necessary, provide a suitable membrane so that damage and nuisance from interstitial condensation do not occur.

230 INSULATION

- Requirement: Determine type and thickness of insulation and integral or separate overlay to satisfy the following criteria:
  - Thermal transmittance of the roof (maximum): as calculated to suit mechanical requirements as indicated in general notes but not more than 0.228 W/(m2·K) for total built up system.
  - Compressive strength of insulation (minimum) at 10% compression: 350 kPa.
  - Finished surface: Suitably even, stable and robust to receive roof covering.
  - Insulation compliance: To a relevant European Standard, or Agreement certified.

PRODUCTS

325 ADHESIVE for bonding membranes at seams and only for point bonding membrane to substrate considering that membrane should be loosely laid

- Type: As membrane manufacturer's/ supplier's recommendations for conditions and surface.
- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.

340 PREFORMED SLEEVES

- Type: non-vulcanized rubber sleeves and accessories as recommended by manufacturer.
- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Colour: Black.
- Size: As drawing.

355 MECHANICAL FASTENERS, WASHERS, PRESSURE PLATES, ETC

- Type: Point fastener.
  - Material: As membrane manufacturer's/ supplier's recommendations.
- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.

375 MINOR MOVEMENT JOINTS IN SUBSTRATES

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Size: As drawings.
- Insert colour: Grey.

380 PROTECTION LAYER, WHERE INDICATED

- Type: Nonwoven geotextile, polypropylene fabric membrane as membrane manufacturer's/ supplier's recommendations.
- Manufacturer: Submit proposals to Engineer's approval.
  Product reference: Submit proposals to Engineer's approval.
- Grade: 200 g/m².

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383 SEPARATING LAYER

- Type: Nonwoven geotextile, polypropylene fabric membrane as membrane manufacturer's/ supplier's recommendations .
- Manufacturer: Submit proposals to Engineer's approval.
  Product reference: Submit proposals to Engineer's approval.
- Grade: 200 g/m².

395 VAPOUR CONTROL LAYER

- Type: Two-layer, fire-retardant polyethylene laminate reinforced with cord grid, as recommended by membrane manufacturer/supplier .
- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Thickness: 1200 gauge.
- Vapour resistance: 1300 MN s/g.
- Reaction to fire: Minimum Euro class B-s1, d0 to BS EN 13501-1

400A WATERPROOF MEMBRANE

- Type: Ethylene propylene diene monomer (EPDM).
- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Width: manufacturer's standard.
- Thickness: Minimum 1.52 mm.
- Colour: black, unless othewise indicated.
- Guarantee: 25 years.
- EPDM MEMBRANE SHALL HAVE:
  - High tensile strength and elongation at break.
  - 100% ozone and UV – radiation resistance.
  - Permanent elasticity.
  - Resistant to chemicals.
  - Resistant to root penetration (FLL approved in accordance with DIN 4102 T7).
  - Self-extinguishing (NEN 6383).
  - Excellent temperature stability from -40 to + 120ºC.

- Typical Properties and Characteristics
  - Essential Characteristics Performance Test Standard
  - Visible Defects Pass EN 1850-2
  - Width -0,5 % to +1 % of target. Test Standard EN 1848-2
  - Straightness -50 mm to +50 mm. Test Standard EN 1848-2
  - Flatness = 10 mm. Test Standard EN 1848-2
  - Effective Thickness -5 % to +10 % of target. Test Standard EN 1849-2
  - External Fire Performance BROOF (t1) and BROOF (t4). Test Standard ENV 1187
  - Reaction to Fire E. Test Standard EN 13501-1
  - Tensile Strength = 8 N/mm². Test Standard EN 12311-2
  - Elongation = 350 %. Test Standard EN 12311-2
  - Tear Resistance = 25 N. Test Standard EN 12310-2
  - Dimensional Stability = 0,5 %. Test Standard EN 1107-2?0
  - UV Exposure Pass. Test Standard EN 1297
  - Resistance to Ozone Pass. Test Standard EN 1844
  - Tensile Strength @ break (MPa): No Aging – (L, T) = 8,0. Test Standard ISO R 527 parts 1 & 3

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- Oxidation – 90 days @ 85°C = 25%. Test Standard PR EN 14575
- Weathering – 3000 hours UV = 25%. Test Standard EN 12224
- Static Puncture (KN) = 0,5. Test Standard EN ISO 12236
- Water Permeability (m^3/m^2)/d 0. Test Standard PR EN 14150
- Durability - Environmental Stress Cracking (hours): = 200. Test Standard ASTM D 5397-99 Appendix

440A INVERTED ROOF INSULATION

- Type: Fire retardant Extruded polystyrene board, suitable for load-bearing and inverted roof applications.
- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Standard: To BS EN 13164.
  - Reaction to fire: Euro class E, flame retardant boards.
  - Thermal conductivity (minimum): 0.030 W/mK.
  - Thickness: As drawing.
  - Compressive strength (minimum): 350 kPa.
  - Other characteristics: Density: 40 kg/cu.m.
- Edges: Rebated.
- Integral topping: Not required.
- Recycled content: Contractor's Choice.

460 STONE BALLAST

- Type: Washed, round aggregate.
- Supplier: Submit proposals to Engineer's approval.
- Size: Size 2, ranging in size from 38 to 63 mm .
- Colour: white.

465 PRECAST CONCRETE PAVING SLABS

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Standard: To BS EN 1339, hydraulically pressed.
  - Size: 500 x 500 x 50 mm unless otherwise indicated.
  - Water absorption: Manufacturer's standard but not more than 5%.
  - Resistance to freeze thaw: Manufacturer's standard.
  - Breaking load (minimum): 5.6 KN to BS EN 1339.
  - Colour: Natural, unless otherwise indicated.
  - Finish: Pimple surface unless otherwise indicated.
  - Other BS EN 1339 characteristics: None.
- Recycled content: Contractor's choice.

EXECUTION GENERALLY

510 ADVERSE WEATHER

- General: Do not lay membrane at temperatures below 5°C or in wet or damp conditions unless effective temporary cover is provided over working area.
- Unfinished areas of roof: Keep dry and protect edges of laid membrane from wind action.

520 INCOMPLETE WORK

- End of working day: Provide temporary seal to prevent water infiltration.
- On resumption of work: Cut away tail of membrane from completed area and remove from roof.

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530 APPLYING PRIMERS

- Coverage per coat (minimum): 0.2 L/m².
- Surface coverage: Even and full.
- Coats: Fully bonded. Allow volatiles to dry off thoroughly between coats.

550 CONTROL SAMPLES

- Type of covering: as indicated.
- Sample area (minimum): as determined by Engineer.
  - Location: as determined by Engineer.
  - Features: Movement joints, upstands and as determined by Engineer.
- Approval of appearance: Obtain before proceeding with remaining work.

610 SUITABILITY OF SUBSTRATES

- Surfaces to be covered: Secure, clean, dry, smooth, free from frost, contaminants, voids and protrusions.
- Preliminary work: Complete, including
  - Grading to correct falls.
  - Formation of upstands, kerbs, box gutters, sumps, grooves, chases and expansion joints.
  - Fixing of battens, fillets and anchoring plugs/ strips.
- Moisture content and stability of substrate: Must not impair integrity of roof.

WATERPROOF MEMBRANES/ ACCESSORIES

710A MECHANICAL FIXING OF WATERPROOF MEMBRANE (MEMBRANES ARE LOSELY LAID UNLESS MECHANICAL FIXING IS REQUIRED FOR POINT SUPPORT)

- Setting out: Perpendicular to the deck direction.
- Laying: Loose, do not wrinkle or stretch.
- Installing fasteners:
  - Use manufacturer's/ supplier's recommended methods and equipment.
  - Insertion: Correct and consistent.
- Washers/ Pressure plates/ Bars:
  - Distance from fixed edge (minimum): 10 mm.
  - Fixing: Flush with membrane.
- Sheet overlaps: Extend beyond washers/ pressure plates by minimum 50 mm.
- Surface condition at completion: Fully sealed, smooth, weatherproof and free draining.

740 ADHESIVE JOINTING OF WATERPROOF MEMBRANE

- Side and end joints:
  - Laps (minimum): 150 mm.
  - Preparation: Prime, clean and dry surfaces beyond full width of joint and lap.
  - Sealing: Apply continuous even coverage of adhesive to both surfaces. Mate and roll together. Do not wrinkle or stretch membrane.
- Seam sealant: Not required.
- Condition at completion: Fully sealed, smooth, weatherproof and free draining.

760 PERIMETERS OF MEMBRANE AND FLASHING

- General: Secure membrane at roof edge conditions, changes of plane, curb flashings, upstands to roof lights, etc. with mechanical fasteners.
- Perimeter metal flashing: minimum 1.5-mm- thick predrilled stainless steel or aluminium sheets; with stainless steel 316 fasteners.

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775 PERIMETER DETAILS FOR ELASTOMERIC MEMBRANES

- Upstands, edge trims, drips, kerbs, etc: Preformed from waterproof membrane material.
- Reinforcing strip: Lay at edge of horizontal roof plane.
  - Securing: Mechanically fasten.
- Roof membrane: Dress over perimeter profiles.
  - Sealing: Bond to substrate and to secured perimeter reinforcing strip.

785 ROOF PENETRATIONS THROUGH ELASTOMERIC MEMBRANES

- Roof membrane: Cut around penetrations.
- Flanged sleeve:
  - Type: Preformed flanged sleeve.
  - Installation: Dress over and around penetration.
  - Seating: Flush to roof membrane.
  - Roof membrane overlap to flange (minimum): 75 mm beyond fasteners.
  - Sealing: Adhesive.

SURFACING

810 LAYING INVERTED ROOF INSULATION

- Condition of substrate: Clean.
- Setting out: Loose lay with staggered joints.
  - Cutting: Minimize.
  - Small cut pieces: Avoid at perimeters and penetrations.
  - Joints: Butt together.
- Projections, upstands, rainwater outlets, etc: Cut insulation cleanly and fit closely around.
- Completion:
  - Insulation boards to be in good condition, well-fitting and stable.
  - Cover to prevent wind uplift and flotation as soon as practicable.

820 LAYING STONE BALLAST

- Condition of substrate: Clean.
- Gravel guards: Fit to outlets.
- Previously laid materials: Protect whilst laying ballast.
- Laying: Spread evenly. Do not pile to excessive heights.
  - Depth (minimum): 100 mm unless otherwise indicated on drawings.

840 LAYING PRECAST CONCRETE PAVING SLABS

- Condition of substrate: Clean.
- Setting out: Minimize cutting.
- Joints: Open.
  - Width: 7 mm open joints unless indicated otherwise.
  - Perimeter/ Upstand margins: indicated width, stone ballast filled.
- Completion: Slabs must be level and stable.

COMPLETION

910 INSPECTION

- Interim and final roof inspections: Submit reports.

930 FLOOD TEST OF ROOF

- Condition of roof prior to testing:

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  - Waterproof membrane complete to a stage where integrity can be tested.
- Outlets: Externally cover and seal. Protect against damage from water pressure using temporary kerbs. Do not use plugs to seal outlets.
- Flood levels: Submit proposals. In no case higher than kerbs.
- Flood duration: Three days.
- Inspection: Regular, to detect leaks.
- Completion of test: Slowly drain roof. Do not overload or flood outlets.
- Test results and warranty: Submit on completion of testing.

940 COMPLETION

- Roof areas: Clean.
  - Outlets: Clear.
- Work necessary to provide a weathertight finish: Complete.
- Storage of materials on finished surface: Not permitted.
- Completed membrane: Do not damage. Protect from traffic and adjacent or high-level working.

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K10 GYPSUM BOARD DRY LININGS/ PARTITIONS/ CEILINGS

To be read with Preliminaries/ General Conditions.

TYPES OF DRY LINING

115 METAL STUD PARTITION SYSTEM generally

- Partition type: Double row studs or single row studs or staggered studs or shaft wall, as indicated on drawings.
- Partition height: as indicated.
- Head condition: as indicated.
  - Deflection allowance: 15 mm maximum.
- Structural performance:
  - Strength grade to BS 5234-2: Heavy.
    Additional tests: Crowd pressure (Annex G).
  - Air pressure and deflection: Air pressure (maximum) 200 N/m² and deflection (maximum) height ÷ 240 mm.
  - Other requirements: where indicated, Allow for weight of ceramic tiles, as section M40.
- Fire performance:
  - Reaction to fire: To BS EN 13501-1, class B-s3, d2 or better.
  - Fire resistance of complete partition assembly: To BS EN 13501-2. EI 60 or 90 or 120 as indicated on fire report.
- Airborne sound insulation
  - Laboratory measurement of complete partition assembly:
  - Weighted sound reduction index Rw (minimum) to BS EN ISO 717-1: Not less than the Rw in dB as indicated in the Acoustics Report.
- Metal framing: Type recommended by board manufacturer to complete the partition assembly and achieve specified performance.
- Insulation: Mineral wool to BS EN 13162; density not less than 60 kg/m³.
  - Recycled content: Contractor's choice.
  - Thickness: 100 mm unless otherwise indicated on drawings and in acoustics report.
- Resilient layer: not required.
- Linings: as indicated on drawings.
- Finishing: Seamless jointing.
  - Primer/ Sealer: As recommended by board manufacturer for vapour control and subject to Engineer's approval in compliance with the finish manuals.
  - Accessories: Rigid beads/ stops as recommended by board manufacturer and subject to Engineer's approval.
- Other requirements: Fire stopping around services as section P12.

145 WALL LINING SYSTEM (METAL STUDS) generally

- Cavity between wall and studs: as indicated on drawings.
- Wall lining height: as indicated on drawings.
  - Intermediate bracing: as recommended by manufacturer.
- Head condition: Concrete slab unless otherwise indicated on drawings.
  - Deflection allowance: Up to ± 15 mm maximum.
- Structural performance:
  - Strength grade to BS 5234-2: heavy.
    Additional tests: Crowd pressure (Annex G).

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  - Air pressure and deflection: Air pressure (maximum) 200 N/m² and deflection (maximum) height ÷240.
  - Other requirements: where indicated, Allow for weight of ceramic tiles, as section M40.
- Fire performance:
  - Reaction to fire: To BS EN 13501-1, class B-s3, d2 or better.
- Fire resistance of complete wall lining assembly: To BS EN 13501-2. EI 60 or 90 or 120 as indicated on drawings and in the fire report.
- Thermal resistance (R) of complete wall lining assembly (excluding surface resistances): Not less than 2.8 m²K/W.
- Metal framing: Type recommended by board manufacturer to complete the partition system and achieve specified performance.
- Insulation: Mineral wool to BS EN 13162; density not less than 80 kg/m³.
  - Recycled content: Contractor's choice.
  - Thickness: as indicated on drawings.
- Moisture vapour resistance (minimum): 150 MNs/g.
- Resilient layer: not required.
- Linings: as indicated on drawings.
- Access units: as indicated on drawings.
- Finishing: Seamless jointing.
  - Primer/ Sealer: As recommended by board manufacturer for vapour control and subject to Engineer's approval in compliance with the finish manuals.
  - Accessories: Rigid beads/ stops as recommended by board manufacturer and subject to Engineer's approval.
- Other requirements: Fire stopping around services as section P12.

165 WALL LINING SYSTEM (METAL FRAMING) generally

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Wall: Concrete blockwork.
- Cavity between wall and back of lining: as indicated.
  - Framing centres: 600 mm unless otherwise recommended by Manufacturer.
  - Bracket centres (maximum): 600 mm.
- Insulation: Mineral wool to BS EN 13162; density not less than 80 kg/m³.
  - Recycled content: Contractor's choice.
  - Thickness: as indicated.
- Resilient layer: not required.
- Linings: as indicated on drawings.
- Access units: as indicated on drawings.
- Finishing: Seamless jointing.
  - Primer/ Sealer: As recommended by board manufacturer for vapour control and subject to Engineer's approval in compliance with the finish manuals.
  - Accessories: Metal beads/ stops recommended by board manufacturer.
- Other requirements: Fire stopping around services as section P12.

175 WALL LINING SYSTEM (METAL FURRINGS) generally

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Wall: Concrete blockwork.
- Furring centres: 400 mm unless otherwise recommended by manufacturer.
- Resilient layer: not required.

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- Linings: as indicated on drawings, of type and thickness as recommended by manufacturer to meet performance requirements.
- Finishing: Seamless jointing.
  - Primer/ Sealer: As recommended by board manufacturer for vapour control and subject to Engineer's approval in compliance with the finish manuals.
  - Accessories: Metal beads/ stops recommended by board manufacturer.
- Other requirements: Fire stopping around services as section P12.

215 SUSPENDED CEILING SYSTEM generally

- Standard: To BS EN 13964.
- Evidence of compliance: All ceilings' kits to be CE marked. Submit Declaration of Performance (DoP).
- Lining board: as indicated on drawings and as recommended by manufacturer to comply with performance requirements.
  - Finishing: Seamless jointing.
    Primer/ Sealer: Type recommended by lining board manufacturer for vapour control and as indicated in the finish manuals to the Engineer's approval.
  - Accessories: Metal beads/ stops recommended by lining board manufacturer.
- Suspension system: As recommended by lining manufacturer to complete the ceiling system and achieve specified performance.
  - Grid type: double with primary channels unless otherwise indicated on drawings and recommended by manufacturer to comply with performance requirements, including structural, acoustical and fire requirements.
  - Hangers: Type recommended by board manufacturer.
    Length: as indicated.
  - Top fixing: To suit structural soffit of concrete beams and blocks unless otherwise indicated.
- Insulation: Mineral wool to BS EN 13162; density (minimum) 80 kg/m³.
  - Recycled content: Contractor's choice.
  - Thickness: as indicated on drawings to meet acoustic and performance requirements.
- Access units: Required, as indicated on drawings and as per manufacturer's recommendations.
- Integrated services fittings: provide cut-outs and trims as required for the installation of building services accessories.
- Other requirements: Fire stopping around service penetrations as section P12.
- System performance:
  - Standard: To BS EN 13964.
  - Structural: The ceiling system must safely support all anticipated loads including services fittings.
    Uniformly distributed load (maximum): 0.6 kN/m².
    Additional loads/ pressures: fire detection, firefighting, air conditioning, Luminaires and other building services accessories as drawings and schedules.
    Deflection of grid between points of support (maximum): 0.0025 x span.
  - Fire performance:
    Reaction to fire: To BS EN 13501-1, class B-s3, d2 or better.
  - Fire resistance: To BS EN 13501-2. REI 30 or 90 or 120 as indicated on drawings and in the fire report.
  - Airborne sound insulation (complete floor and ceiling assembly):
    Weighted sound reduction index, Rw (minimum), to BS EN ISO 717-1: as indicated in the acoustics report.

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Other requirements: Weighted standardized level difference, DnT,W (minimum) to BS EN ISO 717-1 when combined with partition to be in compliance with the acoustics report.

- Electrical continuity and earth bonding: Not required.
- Other BS EN 13964 characteristics: None.

255 ENCASEMENT SYSTEM (METAL FRAMING) generally

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals to the Engineer's selection.
- Structural members: as indicated on drawings.
  - Extent of protection: Columns: Four sides, beams: three sides.
- Fire performance:
  - Protection to structural steel: To BS EN 13501-2. REI 90 or 120 where indicated on drawings and in fire report.
- Framing system: Sizes and spacing of framing and fixings as recommended by the board manufacturer.
- Linings: as recommended by manufacturer to comply with performance requirements.
- Finishing: Seamless jointing.
  - Primer/ Sealer: Type recommended by lining board manufacturer for vapour control and as indicated in the finish manuals to the Engineer's approval.
  - Accessories: Metal beads/ stops recommended by board manufacturer.
- Other requirements: Plan dimensions of casings to be the same for all columns, unless otherwise indicated.

GENERAL/ PREPARATION

305 COMPLIANCES WITH PERFORMANCE REQUIREMENTS

- Testing/ Assessment: Submit UKAS accredited laboratory reports for the following: Fire resistance: Partitions (including deflection heads and door sets) and suspended ceilings (including access units).
- Materials, components and details: As used in testing/ assessment reports. If discrepancies arise, give notice.

325 PREPARATION OF MASONRY TO RECEIVE WALL LININGS

- General: Suitable to receive lining system. Redundant fixtures and services removed. Cutting, chasing and making good completed.
- Holes, gaps, service penetrations, perimeter junctions and around openings: Seal.
- Adhesive fixings: Prepare substrate to achieve effective bonding.
  - Contaminants: Remove loose material, dirt, grease, oil, paper, etc.
  - Absorption: Control by dampening, priming or applying bonding agents as necessary.

335 ADDITIONAL SUPPORTS

- Framing: Accurately position and securely fix to give full support to:
  - Partition heads running parallel with but offset from main structural supports.
  - Fixtures, fittings and service outlets. Mark framing positions clearly and accurately on linings.
  - Board edges and lining perimeters, as recommended by board manufacturer to suit type and performance of lining.

375 NEW WET LAID BASES

- DPCS: Install under full width of partitions/ freestanding wall linings.
  - Material: Bituminous sheet or plastics.

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395 CONTROL SAMPLES

- General: Complete areas of finished work and obtain approval of appearance before proceeding.
- Type of dry lining: for ceiling and partition types as directed by Engineer.
  - Location/ Size: as directed by Engineer.

COMPONENTS

400 GYPSUM BOARDS GENERALLY

- Standard:
  - Gypsum plasterboard to BS EN 520.
  - Gypsum fibre board to BS EN 15283-2.
  - Evidence of compliance: All sheets to be CE marked. Submit Declaration of Performance (DoP).

401 GYPSUM PLASTERBOARD

- Type: To BS EN 520, type A.
- Dimensions: As indicated in finish manuals.
- Thickness: Not less than 12.7mm.
- Core density (minimum): 650 kg/m³.
- Reaction to fire: Class A2-s1, d0.
- Water vapour resistance factor: Dry - 10 μ to BS EN 12524.
- Thermal conductivity: 0.25 W/(m·K) to BS EN 12524.
- Other BS EN 520 characteristics: None.
- Recycled content: Contractor's choice.
- Exposed surface and edge profiles: Suitable to receive specified finish.

403 GYPSUM PLASTERBOARD (MOISTURE RESISTANT)

- Type: To BS EN 520, type H3.
- Core: Moisture resistant.
  - Density (minimum): 710 kg/m³.
- Dimensions: As indicated in finish manuals.
- Thickness: Not less than 12.7mm.
- Paper facings: Moisture resistant.
- Reaction to fire: Class A2-s1, d0.
- Water vapour resistance factor: Dry - 10 μ.
- Thermal conductivity: 0.25 W/(m·K).
- Other BS EN 520 characteristics: None.
- Recycled content: Contractor's choice.
- Exposed surface and edge profiles: Suitable to receive specified finish.

403 ACOUSTICAL GYPSUM BOARD CEILING

- Type: Acoustical seamless gypsum board ceiling suspended system.
- Standard: To BS EN 520.
- Core: Aerated gypsum core, minimum 12.5 mm thickness.
- Edges: Tapered edges.
- Board weight (12.5 mm): 7.8 kg/m².
- Finish: Seamless surface finished with paint, as indicated in finish manuals.
- Colour: As indicated in finish manuals.
- Fire performance: Class 1.
- Reaction to fire: Minimum A2-s1, d0.

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- Thermal conductivity: 0.25 W/(m·K).
- Water vapour resistance factor: Dry – 10 μ.
- Recycled content: Contractor's choice.
- Installation: Suspended ceiling system, joints finished flush to achieve seamless effect.
- Exposed surface and edge profiles: Suitable to receive specified paint finish.

404 GYPSUM PLASTERBOARD (IMPROVED FIRE PROTECTION)

- Type: To BS EN 520, type F.
- Dimensions: As indicated in finish manuals.
- Thickness: As required to achieve the fire performance indicated in FLS report, but not less than 12.7mm.
- Core: Including fibres and/ or other additives for improved cohesion.
  - Density (minimum): 800 kg/m³.
- Reaction to fire: Class A2-s1, d0.
- Water vapour resistance factor: Dry - 10 μ.
- Thermal conductivity: 0.25 W/(m·K).
- Other BS EN 520 characteristics: None.
- Recycled content: Contractor's choice.
- Exposed surface and edge profiles: Suitable to receive specified finish.

406 GYPSUM PLASTERBOARD (IMPROVED FIRE PROTECTION AND MOISTURE RESISTANT)

- Type: To BS EN 520, type H1 and F.
- Dimensions: As indicated in finish manuals.
- Thickness: As required to achieve the fire performance indicated in FLS report, but not less than 12.7mm.
- Core: Moisture resistant and including fibres and/ or other additives for improved cohesion.
  - Density (minimum): 800 kg/m³.
- Paper facings: Moisture resistant.
- Reaction to fire: Class A2-s1, d0.
- Water vapour resistance factor: Dry - 10 μ.
- Thermal conductivity: 0.25 W/(m·K).
- Other BS EN 520 characteristics: None.
- Recycled content: Contractor's choice.
- Exposed surface and edge profiles: Suitable to receive specified finish.

409 GYPSUM PLASTERBOARD (IMPROVED SOUND INSULATION)

- Type: To BS EN 520, type D.
- Dimensions: As indicated in finish manuals.
- Thickness: As required to achieve the sound insulation performance indicated in acoustic report, but not less than 12.7mm.
- Core density (minimum): 820 kg/m³.
- Reaction to fire: Class A2-s1, d0.
- Water vapour resistance factor: Dry - 10 μ.
- Thermal conductivity: 0.25 W/(m·K).
- Other BS EN 520 characteristics: None.
- Recycled content: Contractor's choice.
- Exposed surface and edge profiles: Suitable to receive specified finish.

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425 ACOUSTICAL CEMENT BOARD

- Type: To BS EN 12467, Category A, Class 2 or better, reinforced fibre-cement board with integrated or applied acoustical properties.
- Thickness: As required to achieve the sound insulation performance indicated in acoustic report, but not less than 12.7mm.
- Acoustic performance: As indicated in acoustic report and tested to BS EN ISO 354.
- Reaction to fire: Class A2-s1, d0 to BS EN 13501-1.
- Moisture resistance: Category A (suitable for external exposure) to BS EN 12467.
- Durability: Freeze-thaw, soak-dry, and heat-rain resistant per BS EN 12467.
- Other BS EN characteristics: None.
- Recycled content: Contractor's choice.

430 ACCESS PANELS

Generally:

- Type: 60 minutes fire protection to BS 476-22.
  - Sizes: as indicated.
- Frame: Bead for taping and jointing.
- Panel: Metal with powder coated factory finish.
- Lock: Tamper proof and operated by castellated key.

432 METAL STUDS

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.

INSTALLATION

435 DRY LININGS GENERALLY

- General: Use fixing, jointing, sealing and finishing materials, components and installation methods recommended by board manufacturer.
- Cutting gypsum boards: Neatly and accurately without damaging core or tearing paper facing.
  - Cut edges: Minimize and position at internal angles wherever possible. Mask with bound edges of adjacent boards at external corners.
- Fixings boards: Securely and firmly to suitably prepared and accurately levelled backgrounds.
- Finishing: Neatly to give flush, smooth, flat surfaces free from bowing and abrupt changes of level.

445 CEILINGS

- Sequence: Fix boards to ceilings before installing dry lined walls and partitions.
- Orientation of boards: Fix with bound edges at right angles to supports and with ends staggered in adjacent rows.
- Two-layer boarding: Stagger joints between layers.

455 METAL FRAMING FOR PARTITIONS/ WALL LININGS

- Setting out: Accurately aligned and plumb.
  - Frame/ Stud positions: Equal centres to suit specified linings, maintaining sequence across openings.
  - Additional studs: To support vertical edges of boards.
- Fixing centres at perimeters (maximum): 600 mm.
- Openings: Form accurately.
  - Door sets: Use sleeved or boxed metal studs and/ or suitable timber framing to achieve strength grade requirements for framing assembly and adequately support weight of door.

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- Services penetrations: Allow for associated fire stopping.

465 STAGGERED STUD PARTITIONS

- Horizontal frame members (noggins, bearers, etc.) and boards: Fix between alternate studs and not touching adjacent offset studs.

475 METAL FURRINGS FOR WALL LININGS

- Setting out: Accurately aligned and plumb.
  - Vertical furring positions: Equal vertical centres to suit specified linings, maintaining sequence across openings. Position adjacent to angles and openings.
  - Additional vertical furring: To support vertical edges of boards and at junctions with partitions.
  - Horizontal furring positions: To provide continuous support to edges of boards.
- Adhesive bedding to furring:
  - Dabs: Length 200 mm (minimum). Located at ends of furring's and thereafter at 450 mm (maximum) centres.
  - Junctions with partitions: Continuous bed with no gaps across cavity.

485 SUSPENDED CEILING GRIDS

- Setting out: Accurately aligned and level.
  - Grid members and hangers: Centres to suit specified linings and imposed loads.
  - Additional grid members: Provide bracing and stiffening at upstands, partition heads, access hatches, etc.
- Fixing: Securely at perimeters, grid joints, top and bottom hanger fixings.

505 INSTALLING MINERAL WOOL INSULATION

- Fitting insulation: Closely butted joints and no gaps. Use fasteners to prevent slumping or displacement.
- Services:
  - Electrical cables overlaid by insulation: Sized accordingly.
  - Ceilings: Cut insulation around electrical fittings, etc.

510 SEALING GAPS AND AIR PATHS

- Location of sealant: To perimeter abutments and around openings.
  - Pressurized shafts and ducts: At board-to-board and board-to-metal frame junctions.
- Application: To clean, dry and dust free surfaces as a continuous bead with no gaps.
  - Gaps greater than 6 mm between floor and underside of gypsum board: After sealing, fill with jointing compound.

530 CAVITY FIRE BARRIERS WITHIN PARTITIONS/ WALL LININGS

- Metal framed systems:
  - Material: Plasterboard of thickness and type as indicated on drawings and in compliance with performance requirements, with fire report and with acoustic report.
  - Installation: Form accurately and fix securely with no gaps to provide a complete barrier to smoke and flame.
- Adhesive fixed wall lining systems:
  - Material: Adhesive compound.
  - Installation: Form in a continuous line with no gaps to provide a complete barrier to smoke and flame.

545 CAVITY FIRE BARRIERS WITHIN SUSPENDED CEILINGS

- Type: As recommended by board manufacturer to meet specified performance.

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- Fire resistance: To BS 476-20, 60/60 minutes (Integrity/ Insulation), unless otherwise indicated in the fire report.
- Ceiling void subdivision: Fix barriers as indicated on drawings and in compliance with fire report.
- Fixing at perimeters and joints: Secure, stable and continuous with no gaps, to provide a complete barrier to smoke and flame.
- Service penetrations: Cut and pack to maintain barrier integrity. Sleeve flexible materials. Adequately support services passing through barrier.
- Ceiling systems for fire protection: Do not impair fire resisting performance of ceiling system.

555 FIRE STOPPING AT PERIMETERS OF DRY LINING SYSTEMS

- Material: Tightly packed mineral wool or intumescent mastic/ sealant.
- Application: To perimeter abutments to provide a complete barrier to smoke and flame.

560 JOINTS BETWEEN BOARDS

- Tapered edged gypsum boards:
  - Bound edges: Lightly butted.
  - Cut/ unbound edges: 3 mm gap.
- Square edged plasterboards: 3 mm gap.
- Square edged gypsum fibre boards: 5 mm gap.

565 VERTICAL JOINTS

- Joints: Centre on studs.
  - Partitions: Stagger joints on opposite sides of studs.
  - Two-layer boarding: Stagger joints between layers.

570 HORIZONTAL JOINTS

- Surfaces exposed to view: Horizontal joints not permitted. Seek instructions where height of partition/ lining exceeds maximum available length of board.
- Two-layer boarding: Stagger joints between layers by at least 600 mm.
- Edges of boards: Support using additional framing.
  - Two-layer boarding: Support edges of outer layer.

575 PLANK PLASTERBOARD

- First layer in two-layer boarding: Square edged with long edges at right angles to studs.

580 INSULATION BACKED PLASTERBOARD

- General: Do not damage or cut away insulation to accommodate services.
- Installation at corners: Carefully cut back insulation or plasterboard as appropriate along edges of boards to give a continuous plasterboard face, with no gaps in insulation.

590 FIXING GYPSUM BOARD TO METAL FRAMING/ FURRINGS

- Partitions/ Wall linings: Fix securely and firmly at the following centres (maximum):
  - Single layer boarding: To all framing at 300 mm centres. Reduce to 200 mm centres at external angles.
  - Multi-layer boarding: Face layer at 300 mm centres, and previous layers around perimeters at 300 mm centres.
- Ceilings: 230 mm. Reduce to 150 mm at board ends and at lining perimeters.
- Position of screws from edges of boards (minimum): 10 mm.
  - Screw heads: Set in a depression. Do not break paper or gypsum core.

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592 FIXING INSULATION BACKED PLASTERBOARD TO METAL FURRINGS

- Fixing to furring's: In addition to screw fixings apply continuous beads of adhesive sealant to furring's.

595 DEFLECTION HEADS

- Fixing boards: Do not fix to head channels.

FINISHING

650 LEVEL OF DRY LINING ACROSS JOINTS

- Sudden irregularities: Not permitted.
- Joint deviations: Measure from faces of adjacent boards using methods and straightedges (450 mm long with feet/ pads) to BS 8212, clause 3.3.5.
  - Tapered edge joints:
    Permissible deviation (maximum) across joints when measured with feet resting on boards: 3 mm.
  - External angles:
    Permissible deviation (maximum) for both faces: 4 mm.
  - Internal angles:
    Permissible deviation (maximum) for both faces: 5 mm.

670 SEAMLESS JOINTING TO GYPSUM BOARDS

- Cut edges of boards: Lightly sand to remove paper burrs.
- Filling and taping: Fill joints, gaps and internal angles with jointing compound and cover with continuous lengths of paper tape, fully bedded.
- Protection of edges/ corners: Reinforce external angles, stop ends, etc. with specified edge/ angle bead.
- Finishing: Apply jointing compound. Feather out each application beyond previous application to give a flush, smooth, seamless surface.
- Nail/ screw depressions: Fill with jointing compound to give a flush surface.
- Minor imperfections: Remove by light sanding.

680A SKIM COAT PLASTER FINISH

- Plaster type as recommended by board manufacturer, where required only.
  - Thickness: 2-3 mm, unless otherwise recommended by manufacturer.
- Joints: Fill and tape except where coincident with metal beads.
- Finish: Tight, Matt, smooth surface with no hollows, abrupt changes of level or trowel marks.

692 RIGID BEADS/STOPS

- Internal: To BS EN 13658-1.
- External: To BS EN 13658-2.

695 INSTALLING BEADS/ STOPS

- Cutting: Neatly using mitres at return angles.
- Fixing: Securely using longest possible lengths, plumb, square and true to line and level, ensuring full contact of wings with substrate.
- Finishing: After joint compounds/ plasters have been applied, remove surplus material while still wet from surfaces of beads exposed to view.

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K11 RIGID SHEET FLOORING/ SHEATHING/ DECKING/ SARKING/ LININGS/ CASINGS

To be read with Preliminaries/ General Conditions.

TYPES OF FLOORING/ SHEATHING/ DECKING/ SARKING/ LINING/ CASINGS

110 WOOD-BASED SHEETS GENERALLY

- Standard: To BS EN 13986.
  - Evidence of compliance: All sheets to be CE marked. Submit Declaration of Performance (DoP).

275A ACOUSTIC UNDERLAY WHERE INDICATED

- Substrate: concrete slab.
- System manufacturer: submit proposals to Engineer's approval.
  - Product reference: submit proposals to Engineer's approval.
- Acoustic Underlay
  - Provide heavy-duty acoustic underlayer for screed, toping, floor finishes and where otherwise indicated for occupied areas; made of recycled rubber or other approved-type manufacturer's proprietary material; complete with manufacturer’s standard perimeter wall strip, bond coat, and hi-tack adhesive tape; system-designed to meet or exceed the required impact sound pressure level reduction on slab structures, where indicated or required in the Project.
  - Thickness: 19mm, unless otherwise indicated to meet requirements in Acoustic Report.
  - Load Bearing Capacity: Not less than 3,000 kg/sq. m.
  - Impact sound reduction to comply with values indicated in the Acoustic Report.
  - An impact sound insulation performance of Lnw 38 or better for all normal occupied areas is required.
  - An impact sound insulation performance of Lnw 32 or better for all VIP occupied areas is required.
  - The floor of the rooms above occupied areas should achieve an Rw 70 and an Lnw 28 minimum, and should be floating floor
  - Water Vapour Transmission Rate for underlay (ASTM D 1653 or equivalent European counterpart):.40 g/sqm/24 hrs.
  - Bond Coat: Provide as follows:

    For Dry Areas: High-tack, semi-pressure sensitive, acrylic-based adhesive; one-part; specifically formulated for acoustic underlayer bonding in dry area substrates.

    For Wet Areas: Elastomeric, moisture-cured polyurethane adhesive; one-part; solvent-free.

415 PLYWOOD WALL SHEATHING

- Substrate: galvanized steel studs on concrete walls.
  - Additional supports: as recommended by manufacturer.
- Sheathing: Plywood manufactured to the relevant standards and quality control procedures specified in BS EN 636, and so marked.
  - Type: fire retardant hardwood plywood.
  - Grade: fire retardant.
  - Nominal thickness/ number of plies: 19 mm.
  - Other requirements: plywood to receive two coats of fire-retardant coating as recommended by manufacturer.
- Setting out: Long edges vertical and centred on supports.

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- Expansion gap between adjacent boards (unless otherwise recommended by manufacturer): 2-3 mm.

- Fixing to supports:
  - Fasteners: 60 x 3.35 mm galvanized annular ringed shank nails.
  - Fixing centres (maximum):
    Around board edges: 150 mm.
    Along intermediate supports: 300 mm.
  - Fixing distance from edges (minimum): 25 mm from bottom edge of board and 10 mm from other edges.

815 PLYWOOD GENERALLY

- Substrate: as indicated.
  - Additional supports: as recommended by manufacturer.
- Plywood: Manufactured to an approved national standard.
  - Manufacturer/ Supplier: Submit proposals.
    Product reference: Submit proposals.
  - Face veneer species: Contractor's choice; biological durability appropriate for plywood subject to the risk of attack outlined in BS EN 335, use class 3.
  - Face grain direction: perpendicular to long edges of boards.
  - Bonding quality to BS EN 314-2: Class 1.
  - Appearance class to BS EN 635: Class E.
  - Finish: Sanded.
  - Thickness: 19 mm nominal.
  - Edges: Square.
  - Treatment: Fire retardant impregnation.
  - Other requirements: none.
- Setting out: Long edges running across supports.
  - Gap between adjacent boards: none.
- Fixing to supports:
  - Fasteners: 50 mm x 8 gauge wood screws into pilot holes.
  - Fixing centres (maximum):
    Around board edges: 150 mm.
    Along intermediate supports: 300 mm.
  - Fixing distance from edges (minimum): 10 mm.
- Joint treatment: Bonded with PVA adhesive to BS EN 204, class D3.
- Accessories: none.

875 MEDIUM DENSITY FIBREBOARD GENERALLY, WHERE INDICATED

- Substrate: as indicated.
  - Additional supports: as indicated.
- Medium density fibreboard: To BS EN 622-5, Type MDF.HLS.
  - Manufacturer/ Supplier: Submit proposals.
    Product reference: Submit proposals.
  - Formaldehyde class to BS EN 622-1: Class E1.
  - Fire rating: Class 1 surface spread of flame to BS 476-7.
  - Thickness: 18 mm.
  - Edges: Square.
  - Recycled content: Contractor's choice.
  - Other requirements: none.
- Setting out: Long edges running across supports.

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  - Gap between adjacent boards: as indicated.
- Fixing to supports:
  - Fixing centres (maximum):
    Around board edges: 100 mm.
    Along intermediate supports: 150 mm.
  - Fixing distance from edges (minimum): 12 mm.
- Joint treatment: Bonded with PVA adhesive to BS EN 204, class D3.
- Accessories: none.

880 WOOD STRIP CLADDING

- Type: Solid wood strip wall/ceiling cladding.
  - Grade: Premium.
  - Manufacturer / Reference: Submit proposals to Engineer's approval.
  - Dimensions: As indicated in finish manuals and drawings.
  - Pattern: As indicated in finish manuals and drawings.
  - Finish: As indicated in finish manuals and drawings.
  - Moisture Content: Maximum 8–10%.
  - Edges / Joining: As indicated and approved shop drawings.
  - Width of strips: As indicated; uniform and consistent.
  - Grain / Colour matching: Selected and installed to achieve uniform appearance.
- Substructure / Fixing:
  - Timber or metal support framework as per manufacturer's recommendations.
  - Provide concealed fixing system unless otherwise specified.
- Fire performance: Comply with BS EN 13501-1, minimum Class B-s1,d0 or as required by project.
- Installation:
  - Install in accordance with manufacturer's instructions.
  - Allow for expansion gaps and movement.

880A SOLID METAL CLADDING

- Type: Solid metal sheet cladding system for walls.
  - Material: Metal panels, as indicated.
  - Grade: Suitable for architectural cladding applications.
  - Manufacturer / Reference: Submit proposals for Engineer's approval.
  - Panel size: As indicated in drawings and finishes manual.
  - Thickness: As indicated in drawings and finishes manual.
  - Finish: As indicated in drawings and finishes manual.
  - Colour: As indicated in drawings and finishes manual.
  - Fabrication: Factory-formed panels with folded edges and stiffeners for rigidity, as required.
- Substructure / Support system: Metal support framework as indicated.
- Fixing: Concealed fixing system, in accordance with manufacturer's recommendations.
- Installation: Install plumb, level, and true to line in accordance with manufacturer's instructions.

880B PERFORATED METAL CLADDING

- Type: Perforated metal sheet cladding system for walls.
  - Material: Metal panels, as indicated.
  - Pattern: As selected by engineer full range from manufacturer.
  - Grade: Suitable for architectural cladding applications.
  - Manufacturer / Reference: Submit proposals for Engineer's approval.
  - Panel size: As indicated in drawings and finishes manual.
  - Thickness: As indicated in drawings and finishes manual.
  - Finish: As indicated in drawings and finishes manual.
  - Colour: As indicated in drawings and finishes manual.

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  - Fabrication: Factory-formed panels with folded edges and stiffeners for rigidity, as required.
- Substructure / Support system: Metal support framework as indicated.
- Fixing: Concealed fixing system, in accordance with manufacturer's recommendations.
- Installation: Install plumb, level, and true to line in accordance with manufacturer's instructions.

880C STAINLESS STEEL SKIRTING

- Type: Stainless steel skirting.
  - Material: Stainless steel, as indicated.
  - Grade: Suitable for architectural cladding applications.
  - Manufacturer / Reference: Submit proposals for Engineer's approval.
  - Height: 200 mm, unless otherwise indicated.
  - Thickness: 2mm, unless otherwise indicated.
  - Finish: Brushed finish, unless otherwise indicated.
  - Edges / Profile**:** Straight, true, with smooth finished edges.
  - Fabrication: Factory-formed panels with folded edges and stiffeners for rigidity, as required.
- Fixing: Concealed fixing system, in accordance with manufacturer's recommendations.
- Installation: Install plumb, level, and true to line in accordance with manufacturer's instructions.

WORKMANSHIP

910 INSTALLATION GENERALLY

- Timing: Building to be weathertight before fixing boards internally.
- Moisture content of timber supports (maximum): 18%.
- Joints between boards: Accurately aligned, of constant width and parallel to perimeter edges.
- Methods of fixing, and fasteners: As section Z20 where not specified otherwise.

930 ADDITIONAL SUPPORTS

- Additional studs, noggings/ dwangs (Scot) and battens:
  - Provision: In accordance with board manufacturer's recommendations and as follows:
    Tongue and groove jointed rigid board areas: To all unsupported perimeter edges.
    Butt jointed rigid board areas: To all unsupported edges.
  - Size: Not less than 50 mm wide and of adequate thickness.
  - Quality of timber: As for adjacent timber supports.
  - Treatment (where required): As for adjacent timber supports.

940 BOARD MOISTURE CONTENT AND CONDITIONING

- Moisture content of boards at time of fixing: Appropriate to end use.
- Conditioning regime: Submit proposals.

950 MOISTURE CONTENT TESTING

- Test regime and equipment: Submit proposals.
- Test results: Submit record of tests and results.

960 FIXING GENERALLY

- Boards/ sheets: Fixed securely to each support without distortion and true to line and level.
- Fasteners: Evenly spaced in straight lines and, unless otherwise recommended by board manufacturer, in pairs across joints.
  - Distance from edge of board/ sheet: Sufficient to prevent damage.
- Surplus adhesive: Removed as the work proceeds.

975 METAL WALL FRAMING

- Setting out: Framing accurately aligned, vertical and securely fixed to surrounding structure at maximum 600 mm centres. All board edges supported.

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976 MINERAL WOOL INSULATION TO METAL FRAMING

- Installation: Neat and secure with close butted joints and no gaps. Where insulation is not self-supporting, fixed at head of frame using clips or other suitable proprietary fixings.

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K30 PANEL PARTITIONS

To be read with Preliminaries/ General Conditions.

TYPES OF PARTITION

110A RELOCATABLE PARTITION SYSTEM FIT OUT

- Partition type: Fully glazed.
- Strength grade to BS 5234-2: Heavy (HD).
- Additional tests: Partition stiffness and Resistance to crowd pressure.
- Fire resistance of complete system:
  - Standard: To BS 476-22.
  - Rating: where fire rated partitions are required, rating to be 60 minutes integrity and 60 minutes insulation unless otherwise indicated in the fire and life safety report.
- Reaction to fire rating (for rateable components):
- Class A2 to BS EN 13501-1.
- Sound insulation (minimum):
  - Standard: BS EN ISO 140-4.
  - Rating: not less than 45 dB (Rw) (100-3150 Hz) to glazed panels, unless otherwise indicated on drawings and in acoustic report.
- Accessible design: In accordance with BS 8300.
- Partition height: As indicated on drawing.
- Partition abutments:
  - Head: Concrete slab along with back-to-back angles with silicone seal.
    Deflection allowance: Up to +/- 15 mm.
  - Floor: Concrete slab.
  - Wall/ Vertical structure: Concrete columns/ blockwork.
- Framing/ Perimeters/ Trims: Aluminium, powder coated, colour BS 4800.
- Glazed panels: Full height glazed.
  - Glass types: Acoustic-laminated clear, Class 1B1 to BS EN 12600 safety. Glass to achieve a minimum of -40 dB (Rw) to BS EN ISO 10140-2 and ISO 717-1.
  - Manifestation: Not required.
  - Blinds: where indicated to be Venetian with perforated blades - control integrated within frame, colour: Silver.
- Door sets: Supplied by system manufacturer.
  - Door frames: Aluminium, powder coated, colour to BS 4800.
  - Doors: single glazed leaf on offset pivots/hinges and as schedule.
  - Seals:
  - Acoustic.
  - Combined intumescent and smoke; and
- Intumescent.
  - Threshold: none.
  - Ironmongery: As section P21 and complying with door schedule.
  - Other features: ironmongery to be stainless steel 316.
- Accessories: none.
- Other requirements: none.

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GENERALLY

310 COMPLIANCE WITH PERFORMANCE REQUIREMENTS

- UKAS accredited laboratory test/ assessment reports: Submit for the following:
  - Fire resistance including deflection heads, door sets and over panels;
  - Sound insulation; and
- Structural performance.
- Materials, components and details: In accordance with test/ assessment reports. Give notice if discrepancies arise.

315 ACOUSTIC FIELD TESTS

- Standard: To BS EN ISO 140-4.
- Requirements: 42 dB.

320 SAMPLES

- Representative samples: Before placing orders, submit the following: as indicated.
- Delivered materials/ products: To match samples.

330 CONTROL SAMPLES

- General: Complete areas of finished work and obtain approval of appearance before proceeding.
- Partition types: as indicated.
  - Location/ Size: as indicated.

340 ENVIRONMENTAL CONDITIONS

- General: Before, during and after installation, maintain temperature and humidity levels similar to those that will prevail after building is occupied.

375 NEW WET LAID BASES

- DPCS: Install under full width of partitions.
  - Material: Bituminous sheet or plastics.

380 COORDINATION WITH OTHERS

- Fire/ Sound barriers within floor and ceiling voids: Align accurately with partitions.
- Service runs and outlets: Check designated routes. Do not obstruct outlets and access panels.

INSTALLATION

410 WORKMANSHIPS GENERALLY

- Setting out: Plumb, true to line and level, and free from bowing, undulations and other planar distortions.
- Joints: Align accurately with no lipping.
- Stability: Fix securely, with additional supports where necessary at perimeters.
- Moisture and thermal movement of framing/ panels: Make adequate allowance.

425 INSTALLING RELOCATABLE PARTITIONS

- Site dimensions: Check before installation. Give notice of discrepancies.
- Perimeter abutments: Accommodate deviations whilst maintaining partition system performance. Form make up/ closer pieces accurately around projections and features.
- Customization: Do not cut or otherwise alter framing/ panels on site, except where shown on drawings.
- Intermediate joints in exposed frame members and trims: Keep to a minimum.
- Electrical continuity and earth bonding: To BS 7671 (The IEE Wiring Regulations).

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470 PERIMETER SEALS

- Sealant material: A type recommended by partition/ panel manufacturer.
- Application: Continuously, to clean, dry, dust-free surfaces, leaving no gaps. In accordance with the sealant manufacturer's instructions.

475 FIRE STOPPING

- General: Seal gaps at junctions of partitions with perimeter abutments, cavity barriers, service penetrations etc, to prevent penetration of smoke and flame.
- Materials: Non-combustible or intumescent.

480 GLAZING FOR RELOCATABLE PARTITIONS

- Glass standards: To BS 952 and relevant parts of:
  - BS EN 12150 for thermally toughened glass.
  - BS EN ISO 12543 for laminated glass.
- Insulated glass unit standard: To relevant parts of BS EN 1279.
- Pane size: Within ±2 mm of nominal size.
- Pane condition: Clean and free from obvious scratches, bubbles, rippling, dimples and other defects.
- Glazing standard: To relevant parts of BS 6262.
- Preglazed panes: To be capable of being reglazed in situ.

490 IRONMONGERY FOR RELOCATABLE PARTITIONS

- Frames and doors: Prepare accurately to accept ironmongery and associated fixings.
- Ironmongery installation: Accurate and without damage to components or surrounding surfaces.
  - Fasteners: Supplied by partition/ ironmongery manufacturer. Finish to match component.
- Completion: Check, adjust and lubricate as necessary for correct operation.

495 POST INSTALLATION REQUIREMENTS FOR RELOCATABLE PARTITIONS

- General: Inspect and adjust for correct fit and operation.
- Documentation: Submit for each partition type, including:
  - Partition type and construction.
  - Manufacturer's identity.
  - Sound and fire rating.
  - Surface finishes and Light Reflectance Values (as manufactured).
  - Requirements for fixtures and fittings.
  - Test data and fire certificates.
  - Special requirements.
  - Dismantling and reassembly procedures.
  - Maintenance: Replacement of panels, access to services, cleaning, etc.
- Spares: Provide and hand over to the Employer, as follows: as indicated.

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K32 PANEL CUBICLES/ DUCT AND WALL LININGS/ SCREENS

To be read with Preliminaries/ General Conditions.

120 PANEL CUBICLES GENERALLY

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: to Engineer's approval.
- Panels:
  - Height (overall): 2100 mm unless otherwise indicated.
  - Floor clearance: 100 mm, unless otherwise indicated .
  - Core material: Honeycomb core with phenolic compact laminate facings.
    Thickness: As indicated finish manuals, but not less than 25mm.
  - Facings: Manufacturer's standard as indicated in the finish manual.
    Colour/ Pattern/ Species: As finish Manual.
  - Edge treatment: Manufacturer's standard.
  - Wall support: stainless steel 1.4401 grade 316 Brackets.
- Pilasters:
  - Core material: Honeycomb core with phenolic compact laminate facings.
    Thickness: As indicated finish manuals, but not less than 25mm.
  - Facings: Manufacturer's standard as indicated in the finish manual.
    Colour/ Pattern/ Species: as finish manual.
  - Edge treatment: Manufacturer's standard.
- Doors:
  - Height: 2100 mm unless otherwise indicated.
  - Core material: Honeycomb core with phenolic compact laminate facings.
    Thickness: As indicated finish manuals, but not less than 25mm.
  - Facings: Manufacturer's standard as indicated in the finish manual.
    Colour/ Pattern/ Species: as finish manual.
  - Edge treatment: Manufacturer's standard.
  - Ironmongery: Manufacturer's standard.
    Material: Stainless steel door hardware grade 316.
    Hinges: Self-closing type.
    Lock: With occupancy indicator and emergency access.
    Colour: as selected by Engineer from Manufacturer's standard range.
- Fittings:
  - Headrails: Invisible overhead aluminium frame, unless otherwise indicated on drawings.
- Pedestals/ Shoes: Floor mounted anodized aluminium adjustable foot pedestals.
- Accessories: None.
- Other requirements:
  - Interlocking doors and fascia to provide flush sightline-free appearance.

130 PRIVACY SCREENS BETWEEN URINALS

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Frame/ Supports:
  - Type: wall mounted as indicated on drawings.
  - Material: Manufacturer's standard.
  - Finish: Manufacturer's standard.
- Panels:
  - Height (overall): Manufacturer's standard.

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- Floor clearance: Manufacturer's standard.
- Core material: High pressure laminate (HPL) bonded to high-density resin impregnated particleboard substrate.
  Thickness: 25mm, unless othewise indicated.
- Facings: Manufacturer's standard.
  Colour/ Pattern/ Species: as selected by Engineer from Manufacturer's standard range.
- Edge treatment: Manufacturer's standard.
- Wall support: stainless steel 1.4401 grade 316 Brackets.

- Accessories: none.
- Other requirements: None.

210 SAMPLES

- General: Before placing orders submit representative samples of the following: Panel and door material and colours.
- Delivered materials/ products: To match samples.

220 CONTROL SAMPLES

- General: Complete samples as part of finished work and obtain approval of appearance before proceeding.
- Types: All items specified in this section and applicable to project.
  - Locations: as agreed with Engineer.

250 INSTALLATIONS

- Programming: Do not install cubicles wall panels before building is weathertight, wet trades have finished their work, wall and floor finishes are complete, and the building is well dried out.
- Accuracy: Set out to ensure frames and/ or panels and doors are plumb, level and accurately aligned.
- Modifications: Do not cut, plane or sand prefinished components except where shown on drawings.
- Fixing: Secure components using methods and fasteners recommended by the cubicle/ panel manufacturer. Prevent pulling away, bowing or other distortions to frames, panels and doors.
- Moisture and thermal movement: Make adequate allowance for future movement.

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K40 DEMOUNTABLE SUSPENDED CEILINGS

To be read with Preliminaries/General Conditions.

TYPES OF CEILING SYSTEM

105 SUSPENDED CEILING SYSTEM GENERALLY

- Standard: To BS EN 13964.
- Evidence of compliance: All ceilings kits to be CE marked. Submit Declaration of Performance (DoP).
- Ceiling:
  - Type: Unit/ modular, as indicated in the finish's manual.
  - Module: 600 x 600 mm, unless otherwise indicated on drawings and in finishes manual.
  - Soffit height above finished floor level: as indicated on drawings.
- Grid:
  - Form: Non-interlocking.
  - Exposure: Exposed or semi-concealed, as indicated in the finish's manual and on drawings.
- Access: Access panels as indicated on drawings.
- Suspension system: Required to meet also seismic loads determined by Engineer.
- Perimeter trim: Required.
- Accessories: Air plenum barriers where fire rated plenum barriers are required and indicated in the fire and life safety report.
- Integrated services fittings: Hangers and housings for linear luminaires.
- Other requirements: Install primary grid using manufacturer's recommended system.

115A UNIT/ MODULAR SUSPENDED CEILING SYSTEM WITH FIBREGLASS ACOUSTIC TILES

- Standard: To BS EN 13964.
- Evidence of compliance: All ceilings kits to be CE marked. Submit Declaration of Performance (DoP).
- Ceiling system manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Ceiling:
  - Infill units: lay-in acoustic tiles.
  - Material: High-density glass wool / fiberglass core with factory-applied decorative facing.
  - Ceiling module: 600 x 600 mm, unless otherwise indicated on drawings and in manual.
  - Thickness: As selected by engineer from full range manufacturers, but not less than 25mm.
  - Color/Finish: As selected by engineer from full range manufacturers.
  - Light reflectance (LR): As indicated in finish manual.
  - Sound absorption (NRC): As indicated in acoustical report.
  - Fire performance: Class A to BS EN 13501-1.
  - Humidity resistance: Suitable for up to 95–100% RH without sagging.
  - Soffit height above finished floor level: as indicated.
- Grid:
  - Form: Interlocking exposed tee grid system, unless otherwise indicated on drawings.
  - Exposure: Exposed.
- Access: Infill units fully demountable.
- Suspension system: As clause 250.
- Perimeter trim: As clause 260.
- Accessories: Air plenum barriers as clause 290.

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- Integrated services fittings: as clause 395.
- Other requirements: Insulation as clause 285 and cavity barrier as clause 287.

115B UNIT/ MODULAR SUSPENDED CEILING SYSTEM WITH ACOUSTIC MINERAL FIBRE TILES

- Standard: To BS EN 13964.
- Evidence of compliance: All ceilings' kits to be CE marked. Submit Declaration of Performance (DoP).
- Ceiling system manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Ceiling:
  - Infill units: lay-in acoustic tiles.
  - Ceiling module: 600 x 600 mm, unless otherwise indicated on drawings and in manual.
  - Thickness: As selected by engineer from full range manufacturers, but not less than 25mm.
  - Color/Finish: As selected by engineer from full range manufacturers.
  - Light reflectance (LR): As indicated in finish manual.
  - Sound absorption (NRC): As indicated in acoustical report.
  - Soffit height above finished floor level: as indicated.
- Grid:
  - Form: Interlocking exposed tee grid system unless otherwise indicated on drawings.
  - Exposure: Exposed, unless otherwise indicated on drawings and in manual.
- Access: Infill units fully demountable.
- Suspension system: As clause 250.
- Perimeter trim: As clause 260.
- Accessories: Air plenum barriers as clause 290.
- Integrated services fittings: as clause 395.
- Other requirements: Insulation as clause 285.
- Relative Humidity: maximum 95%.
- Sound attenuation: 36 dB, unless otherwise indicated on drawings and in manual.
- Fire performance: Euro class A2-s1,d0.
- Where indicated for clean rooms, provide units that comply with clean room classification ISO-Class4, in accordance to ISO 14644-1.
- Warranty: not less than15 years from date of taking over.

115 C UNIT/ MODULAR SUSPENDED CEILING SYSTEM WITH MICRO-PERFORATED ALUMINUM PAN CEILING

- Standard: To BS EN 13964.
- Ceiling tiles:
  - Material: Powder-coated aluminium, clip-in system.
  - Perforation: Micro-perforated, hole diameter 1.5 mm.
  - Open area: 22%.
  - Border: 20 mm unperforated edge.
  - Edge detail: 4 mm bevelled edges.
  - Infill: Fiberglass backing for enhanced acoustic performance.
  - Colour/ Finish: As indicated on drawings and finishes manual.
- Acoustical performance: NRC as indicated in Acoustic Report and Drawings.
- Humidity resistance: Suitable for environments up to 95% RH.
- Fire performance: Euro class A2-s1, d0.
- Tile dimensions: 600 x 600 mm, unless otherwise indicated.
- Suspension system: Concealed clip-in system, as recommended by manufacturer.

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- Access: Fully demountable tiles.
- Grid/ framing: Compatible with concealed clip-in suspension system.
- Perimeter trim: As clause 260.
- Accessories: Air plenum barriers (clause 290), integrated service fittings (clause 395).
- Other requirements: Insulation as clause 285.
- Cleanroom performance (where indicated): Provide units compliant with ISO 14644-1, ISO-Class 4.
- Warranty: Not less than 15 years from date of Taking Over.

115 D UNIT/ MODULAR SUSPENDED CEILING SYSTEM WITH PERFORATED STEELTILES

- Standard: To BS EN 13964.
- Ceiling tiles:
  - Material: painted Steel sheet.
  - Steel sheet thickness: minimum 0.5 mm
  - Perforation: as indicated on drawings.
  - Open area: 22%.
  - Border: 20 mm unperforated edge.
  - Infill: Fiberglass backing for enhanced acoustic performance, unless otherwise indicated.
  - Colour and Finish: Light grey, 20 percent Matt, unless otherwise indicated on drawings and finishes manual.
- Acoustical performance: NRC as indicated in Acoustic Report and Drawings
- Humidity resistance: Suitable for environments up to 95% RH.
- Fire performance: Euro class A2-s1, d0.
- Tile dimensions: 600 x 600 mm, unless otherwise indicated.
- Suspension system: Concealed Lay-in system.
- Access: Fully demountable tiles.
- Grid/ framing: Compatible with concealed clip-in suspension system.
- Perimeter trim: As clause 260.
- Accessories: Air plenum barriers (clause 290), integrated service fittings (clause 395).
- Other requirements: Insulation as clause 285.
- Cleanroom performance (where indicated): Provide units compliant with ISO 14644-1, ISO-Class 4.
- Warranty: Not less than 15 years from date of Taking Over.

115 F WOOD-VENEER, LINEAR ACOUSTICAL BAFFLE CEILING

- Linear Baffle ceiling: Manufacturer's standard linear panels fabricated from planks consisting of wood veneer adhered to backs and exposed surfaces with medium density fibreboard composite-wood cores. Planks run parallel to panel length.
- Surface-Burning Characteristics: Provide products with the following characteristics when tested in accordance with BS EN 13501-1, class B-s2, d0
  - Baffle size: as indicated on drawings.
  - Thickness: As indicated.
  - Color: walnut, unless otherwise indicated
  - Veneer Face Grade: Manufacturer's standard Insert requirements.
  - Veneer Species: As indicated in the manual.
  - Veneer Cut: Manufacturer's standard.
  - Nominal Plank Width: As indicated in Interior finish materials manual.
  - Plank Depth: As indicated in Interior finish materials manual.
  - Plank Length: As indicated in Interior finish materials manual.
  - Plank Edges: As indicated in Interior finish materials manual.

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- Panel Attachment: Provide manufacturer's standard attachment hooks or clips for attaching panels to grid suspension system, spaced to support ceiling loads and in accordance with manufacturer's written installation instruction.
- Veneer Adhesive: Manufacturer's standard that complies with "Performance Requirements" Article.
- Plank Finish: Tinted finish in color selected by Engineer from manufacturer's standard.
- Backing Board Gloss and Color: Flat black, unless otherwise indicated.

115 G WOOD-VENEER, ACOUSTICAL PANEL CEILING

- Acoustical wood Ceiling Panels: Manufacturer's standard linear panels fabricated from planks consisting of wood veneer adhered to backs and exposed surfaces with medium density fibreboard composite-wood cores. Planks run parallel to panel length.
- Surface-Burning Characteristics: Provide products with the following characteristics when tested in accordance with BS EN 13501-1, class B-s2, d0
  - Veneer Face Grade: Manufacturer's standard Insert requirements.
  - Veneer Species: As indicated in the manual.
  - Veneer Cut: Manufacturer's standard.
  - Nominal Plank Width: As indicated in the manual.
  - Plank Depth: As indicated in the manual.
  - Plank Length: As indicated in the manual.
  - Plank Edges: As indicated in the manual.
  - Backing Boards: Manufacturer's standard.
  - Panel Module: As indicated in the manual.
  - Panel Attachment: Provide manufacturer's standard attachment hooks or clips for attaching panels to grid suspension system, spaced to support ceiling loads and in accordance with manufacturer's written installation instruction.
  - Veneer Adhesive: Manufacturer's standard that complies with "Performance Requirements" Article.
  - Plank Finish: Tinted finish in color selected by Engineer from manufacturer's standard.

115 H LINEAR-CEILING-PANEL ACCESSORIES

- Linear-Ceiling-Panel Accessories: Linear-ceiling-panel manufacturer's accessories required to provide a complete installation of ceiling in accordance with manufacturer's written installation instructions.
  - Safety Cables: 610 mm.
  - Panel Splice Plates: Manufacturer's standard.
  - Acoustic Infill Panels: Manufacturer's standard to provide NRC rating indicated, with flame-spread index of 25 or less and smoke-developed index of 450 or less as determined by testing in accordance with ASTM E84.
  - NRC: NRC as indicated in Acoustic Report and Drawings.
  - Acoustic Felt: Manufacturer's standard, factory applied, black, backer with flame-spread index of 25 or less and smoke-developed index of 450 or less as determined by testing in accordance with ASTM E84.
  - Veneer Edge Banding: Manufacturer's standard matching planks for treating cut edges; with pressure-sensitive adhesive backing.
  - Trim: As indicated on the Drawings; with trim connectors recommended in writing by ceiling and suspension-system manufacturers.
  - Material: As indicated in the manual.

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135 BOARD SUSPENDED CEILING SYSTEM WHERE INDICATED

- Standard: To BS EN 13964.
- Evidence of compliance: All ceilings kits to be CE marked. Submit Declaration of Performance (DoP).
- Ceiling system manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Ceiling:
  - Boards: As clause 270.
  - Soffit height above finished floor level: as indicated.
- Grid:
  - Form: Non-interlocking.
  - Exposure: Concealed.
- Suspension system:
  - Grid centres: as indicated.
  - Hanger centres: manufacturer's recommendations.
- Access: Access panels indicated on drawing.
- Perimeter trim: Not required.
- Accessories: None.
- Integrated services fittings: None.
- Other requirements: insulation as clause 285.

GENERAL/ PERFORMANCE

205 COMPLIANCE WITH PERFORMANCE REQUIREMENTS

- Testing/ assessment: Submit UKAS accredited laboratory reports for the following: Fire performance.
- Materials, components and details: Use those used in the test and identified in the assessment reports. If discrepancies arise, give notice.

210 ENVIRONMENT

- Environmental classification to BS EN 13964: Class A.
- Release of Formaldehyde to BS EN 13964: Class E1.
- Susceptibility to growth of harmful micro-organisms to BS EN 13964: Level A.

220 STRUCTURAL PERFORMANCE GENERALLY

- Loads: The ceiling system must safely support all anticipated loads, including services fittings:
  - Class: 1.
  - Additional loads/ pressures to be sustained by ceiling system: Lighting, fire detection, firefighting, air conditioning and other building services accessories as indicated on drawings.
    Ceiling system subject to wind pressure: No.
- Deflection (maximum) between points of support:
  - Span under 1200 mm: Span/400.
  - Span 1200-1800 mm: Span/500.
  - Span over 1800 mm: Span/600.
- Test standard: To BS EN 13964.

225 FIRE PERFORMANCE as per fire and life safety drawings and report

- Completed ceiling system: Intended for fire protection.
- Reaction to fire ratings:
  - Ceiling soffit surfaces: To BS EN 13501-1, Euro class A2-s1, d0. Where indicated on drawings and fire report to be classified as Class B.

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  - Ceiling void surfaces: To BS EN 13501-1, Euro class A2-s1, d0. Where indicated on drawings and fire report to be classified as Class B.
- Fire resistance:
  - Overall fire resistance: To BS EN 13501-2, REI 60, unless otherwise indicated on drawings and in fire report.
  - Ceiling resistance: To 13501-2, EI 30, unless otherwise indicated on drawings and in fire report.
  - Other protection: None.
- Test reports or assessments: Include details of performance related to the particular elements of construction.
  - Ceilings with integrated luminaires: Test/ assess with luminaires in place.

230 ACOUSTIC PERFORMANCE AS INDICATED IN THE ACOUSTICS REPORT

- Sound absorption to BS EN ISO 11654: Class A.
- Sound attenuation: Dnf, w (minimum) to BS EN ISO 717-1: as indicated in the acoustics report and on drawings for each area.
- Other acoustic requirements: Weighted standardised level difference, DnT,w (minimum) to BS EN ISO 717-1: as determined in the acoustics report.

COMPONENTS

240 SAMPLES

- General: Submit representative samples of the following: All components for all ceiling systems specified in this section and applicable to the project.

245 STANDARDS

- Steel panels: To BS EN 10346.
- Aluminium sheet, strip and plate: To BS EN 485-1 and -2.
- Aluminium bars, tubes and sections: To relevant parts of BS EN 515, BS EN 573, BS EN 755 and BS EN 12020.

250 SUSPENSION SYSTEM GENERALLY

- Manufacturer: Submit proposals.
  - Product reference: To Engineer's selection.
- Extent of system: Include all hangers, fixings, main runners, cross members, primary channels, perimeter trims, splines, noggings, clips, bracing, bridging, etc. necessary to complete the ceiling system and achieve specified performance.
- Top fixings: wire hanger anchor bolts.
- Hangers: M6 galvanized threaded rods.
- Grid type: special extruded aluminium sections as indicated in the FF&E manual and on drawings.
  - Finish: powder coating, min. 60 microns.
  - Colour: as indicated in the FF&E manual.

260 PERIMETER TRIMS GENERALLY

- Type: 32 x 19 mm steel angle trim, colour and finish to match exposed grid.
- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Fixings:
  - Fasteners: BZP raised head screws.
  - Fixing centres (maximum): 450 mm.

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265 INFILL UNITS WHERE INDICATED

- Type: Fine fissured mineral fibre tiles with rebated edge profile.
- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
  - Form: Pressed units.
  - Sizes: as indicated.
  - Finish: for metal panels insert: Powder coating to Z31 to all surfaces of panel, 60 micrometres minimum film thickness.
  - Colour: to BS 4800.
- Recycled content: Not applicable.

270 BOARDS WHERE INDICATED

- Type: fibre reinforced board, sound absorbent or moisture resistant where indicated.
- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Recycled content: Not applicable.
- Thickness: 12 mm, unless otherwise indicated on drawings and in manual, and as per manufacturer's recommendations to meet performance requirements.
- Sizes: manufacturer's standard size, subject to Engineer's approval.
- Edge profile: Bevelled.
- Fillets/ cover strips: 9 mm thick across full width of channel and 6 x 75 mm behind joints at right angles to channels.
- Finish: Seamless finishing to fibre reinforced gypsum boards.
- Colour: as indicated.
- Other requirements: Predrilled holes for fixings.

280 ACCESS UNITS WHERE INDICATED

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Size: as indicated.
- Frame type: Plaster.
- Fire performance: As suspended ceiling.
- Lock type : 3-point espagnolette bolt.
- Operation: Concealed steel hinges, downward opening.
- Finish: Antibacterial coating.
- Colour: as indicated.

285 INSULATION GENERALLY

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Purpose: Acoustic insulation and fire protection.
  - Performance: 43 dB sound reduction unless otherwise indicated on drawings and in acoustic report.
- Type: Mineral wool pads.
- Recycled content: Contractor's choice.
- Thickness: as indicated on drawings.
- Density: not less than 80 kg/m³.
- Facings/ Wrappings: Aluminium foil to back (facing void) and edges, white glass fibre tissue to front.

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287 CAVITY BARRIERS

- Standard: To BS EN 13501-2.
- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Fire resistance: To BS EN 13501-2, EI 30.
- Type/ Material: Wire reinforced mineral wool.
- Thickness: 100 mm unless otherwise indicated.
- Density: 80 kg/m³.
- Facings/ Wrappings: Aluminium foil to back (facing void) and edges, white glass fibre tissue to front.

290 AIR PLENUM BARRIERS generally

- Material: Rigid or semirigid nonporous sheets with smooth non-dusting surfaces.
- Fire spread rating: Not less than ceiling materials exposed within the ceiling void.

EXECUTION

302 CONTROL SAMPLES

- General: Complete areas as part of the finished work in the following locations: As agreed with the Engineer.
- Approval: Obtain before completing areas of similar work.

305 SETTING OUT

- General: Completed ceiling should present, over the whole of its surface exposed to the room below, a continuous and even surface, jointed (where applicable) at regular intervals.
- Infill and access units, integrated services: Fitted correctly and aligned.
- Edge/ perimeter infill units' size (minimum): Half standard width or length.
- Corner infill units' size (minimum): Half standard width and length.
- Grid: Position to suit infill unit sizes. Allow for permitted deviations from nominal sizes of infill unit.
- Infill joints and exposed suspension members: Straight, aligned and parallel to walls, unless specified otherwise.
- Suitability of construction: Give notice where building elements and features to which the ceiling systems relate are not square, straight or level.

310 BRACING

- General: Secure, with additional bracing and stiffening to give a stable ceiling system resistant to design loads and pressures.

315 PROTECTION

- Loading: Do not apply loads for which the suspension system is not designed.
- Ceiling materials: When necessary, remove and replace correctly using special tools and clean gloves, etc. as appropriate.

320 TOP FIXING

- Building structure: Verify suitability.
- Structural soffit: Existing concrete slab.
  - Suitability to receive specified fixings: Evaluate and confirm.
- Fixing generally: In accordance with BS EN 13964.
- Fixing to:
  - Concrete: Drill and insert suitable expanding anchors.
  - Aerated concrete: Fix through from the top of concrete units and provide a system of primary support channels.

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- Structural steel: Drill or use suitable proprietary clips/ adaptors.
- Metal roof decking: Fix to sides of liner tray corrugations.
- Timber: Fix to side of joists at least 50 mm from bottom edge. If ceiling system is intended for fire protection, fix into top third of joists.
- Hollow structural members: Submit fixing proposals.

325 INSTALLING HANGERS

- Wire hangers: Straighten and tension before use.
- Installation: Install vertical or near vertical, without bends or kinks. Do not allow hangers to press against fittings, services, or insulation covering ducts/ pipes.
- Obstructions: Where obstructions prevent vertical installation, either brace diagonal hangers against lateral movement, or hang ceiling system on an appropriate rigid sub-grid bridging across obstructions and supported to prevent lateral movement.
- Extra hangers: Provide as necessary to carry additional loads.
- Fixing:
  - Wire hangers: Tie securely at top with tight bends to loops to prevent vertical movement.
  - Angle/ strap hangers: Do not use rivets for top fixing.
- Spacings: As indicated in the relevant clauses and on drawings.

335 INSTALLING PERIMETER TRIMS

- Jointing: Neat and accurate, without lipping or twisting.
  - External and internal corners: Mitre joints generally. Overlap joints at internal corners are not acceptable.
  - Intermediate butt joints: Minimize. Use longest available lengths of trim. Align adjacent lengths.
- Fixing: Fix firmly to perimeter wall, edge battens or other building structure.
  - Fasteners: As recommended by the ceiling manufacturer subject to the Engineer's approval.
  - Fixing centres: 450 mm.

340 EXPOSED GRIDS

- Grid fixings: As recommended by the ceiling manufacturer subject to the Engineer's approval.
- Main runners: Install level. Do not kink or bend hangers.
  - Spliced joints: Stagger.
  - Wire hangers passing through main runners: Use sharp bends and tightly wrapped loops.
  - Angle/ strap hangers: Do not use rivets for bottom fixing.
  - Angular displacement of long axis of one runner in relation to next runner in line with it: Not visually apparent.
- Cross members supported by main runners or other cross members: Install perpendicular to intersecting runners.
- Cross tees: Flat and coplanar with flanges of main runners after panel insertion.
  - Cross tees over 600 mm long, cut and resting on perimeter trim: Provide an additional hanger.
- Holding down clips: Locate to manufacturer's recommendations.
  - Fire protecting/ resisting ceiling systems: Use clip type featured in the fire test/ assessment.

345 CONCEALED GRIDS

- Grid fixings: As recommended by the ceiling manufacturer subject to the Engineer's approval.
- Primary support channels: Install level. Do not kink or bend hangers.
  - Wire hangers wrapped around primary channels: Twice wrapped. Loops tightly formed.
  - Angle/ Strap hangers: Do not use rivets for bottom fixing.
- Splines: Locate between infill units to assist levelling of adjacent units and to resist air movement at joints.

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- Spring-tee grids: Do not omit primary channel.

355 INSTALLING INFILL UNITS

- General:
  - Perimeter infill units: Trimmed, as necessary, to fully fill space between last grid member and perimeter trim. Prevent subsequent movement.
  - Deeply textured infill units: Minimize variations in apparent texture and colour. In particular, avoid patchiness.
- Concealed grids: Install infill units uniformly, straight and aligned. Avoid dimension creep.
  - Infill units around recessed luminaires and similar openings: Prevent movement and displacement.

365 INSTALLING METAL INFILL UNITS

- Sound absorbing pads: Fit to prevent upward air movement through infill units. Cut or fold pads in cut perimeter infill units to full unit size. Reseal cut pads.
- Perimeter infill units: Firmly wedge cut units into perimeter trim, or clip down.

375 BOARD CEILING SYSTEMS

- Cut boards: Neat and accurate.
- Fixing to grid:
  - Board edges: Fully support. Screw to grid members. Set heads of screws below surface of boards and fill flush with surface.
  - Boards applied in two or more layers: Stagger joints.
- Movement joints: Provide as appropriate for the area of ceiling system and/ or to coincide with movement joints in surrounding structure.

385 UPSTANDS AND BULKHEADS

- Vertical ceiling systems: Support and brace to provide alignment and stability.
- High upstands: Provide support at base of upstand.

390 OPENINGS IN CEILING MATERIALS

- General: Neat and accurate. To suit sizes and edge details of fittings. Do not distort ceiling system.

395 INTEGRATED SERVICES

- General: Position services accurately, support adequately. Align and level in relation to the ceiling and suspension system. Do not diminish performance of ceiling system.
- Small fittings: Support with rigid backing boards or other suitable means. Do not damage or distort the ceiling.
  - Surface spread of flame rating of additional supporting material: Not less than ceiling material.
- Services outlets:
  - Supported by ceiling system: Provide additional hangers.
  - Independently supported: Provide flanges to support ceiling system.

401 CEILING-MOUNTED LUMINAIRES

- Support: independent.
  - Independently supported luminaires: Suspension adjusted to line and level of ceiling.
  - Ceiling supported luminaires: Modifications and/ or extra support required: no.
- Surface mounted luminaires: Units installed so that in event of a fire the designed grid expansion provision is not affected.
- Modular fluorescent recessed luminaires: Compatible with ceiling module. Extension boxes must not foul ceiling system.

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- Recessed rows of luminaires: Provide flanges for support of grid and infill units, unless mounted above grid flanges. Retain in position with lateral restraint.
- Fire protecting/ resisting ceiling systems: Luminaires must not diminish protection integrity of ceiling system.
- Access: Provide access for maintenance of luminaires.

406 TRUNKING

- Recessed trunking: Provide flanges for support of grid and infill units, unless mounted above grid flanges. Retain in position with lateral restraint.

411 MECHANICAL SERVICES

- Fan coil units:
  - Inlet/ Outlet grilles: Trim ceiling grid and infill units to suit.
  - Space beneath: Sufficient for ceiling system components.
  - Suspension and connections: Permit accurate setting out and levelling of fan coil units.
- Air grilles and diffusers:
  - Setting out: Accurate and level.
  - Linear air diffusers: Retain in place with lateral restraint. Provide flanges for support of grid and infill units.
  - Grille/ Diffuser ceiling joints: Provide smudge rings and edge seals.
- Smoke detectors and PA speakers:
  - Ceiling infill units: Scribe and trim to suit.
  - Independent suspension: Required.
  - Flexible connections: Required.
- Sprinkler heads: Carefully set out and level.

415 INSTALLING INSULATION

- Fitting: Fit accurately and firmly with butted joints and no gaps.
- Insulation within individual infill units: Fit closely. Secure to prevent displacement when infill units are installed or subsequently lifted.
  - Dustproof sleeving: Reseal, if cut.
- Width: Lay insulation in the widest practical widths to suit grid member spacings.
- Services: Do not cover electrical cables that have not been sized accordingly. Cut insulation carefully around electrical fittings, etc. Do not lay insulation over luminaires.
- Sloping and vertical areas of ceiling system: Fasten insulation, to prevent displacement.

421 CEILING SYSTEMS INTENDED FOR FIRE PROTECTION

- Junctions of ceiling systems with perimeter abutments and service penetrations: Seal gaps with tightly packed mineral wool or intumescent sealant to prevent penetration of smoke and flame.
- Ceiling system/ wall junctions: Maintain protective value of ceiling system.
  - Fixings and grounds: Non-combustible.
  - Metal trim: Provide for thermal expansion.
- Access and access panels: Maintain continuity of fire protection.

425 INSTALLING CAVITY FIRE BARRIERS

- Maximum ceiling void dimension in any direction: As indicated on drawings.
- Fixing: As recommended by the ceiling manufacturer subject to the Engineer's approval.
  - General: Fix barriers securely to channels or angles at abutments to building structure.
  - At perimeters and joints: Provide permanent stability and continuity with no gaps to form a complete barrier to smoke and flame.
- Joints: Form to preserve integrity in fire.

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- Service penetrations: Cut barriers neatly to accommodate services. Fit fire resistant sleeves around flexible materials. Fill gaps around services to fire barrier manufacturer's recommendations to maintain barrier integrity. Adequately support services passing through the barrier.
- Ceiling systems intended for fire protection: Do not impair fire resisting performance of ceiling system.
- Ceiling systems not intended for fire protection: Do not mechanically interlink barriers with ceiling system.

431 INSTALLING SOUND BARRIERS

- Material: Wire reinforced mineral wool mat with aluminium foil facing, or equivalent.
- Setting out: Align accurately with partition heads.
- Fixing: Fix tightly at perimeters and joints using methods recommended by barrier manufacturer, including steel support sections as appropriate. Completed installation to be stable, secure and continuous, with no gaps.
- Gaps at junctions with partition heads, ceiling system, structural soffit, walls, ducts, pipes, etc: Seal with mineral wool or suitable sealant.

435 INSTALLING AIR PLENUM BARRIERS

- Fixing: Fix tightly at perimeters and joints using methods recommended by the barrier manufacturer to ensure permanent stability.
- Edges and joints: Seal effectively to prevent air leakage.

500 ELECTRICAL CONTINUITY AND EARTH BONDING

- Inclusion in finished work: Not required.

COMPLETION

505 TOOLS

- Access tools: At Completion, supply one set of the following: All tools required to provide access to the ceiling void as well as, all tools required to dismantle or re-assemble the ceiling system should maintenance works be required in the future.

520 USER INSTRUCTIONS

- Contents: Include the following:
  - Correct methods for removing and replacing infill units and other components.
  - Cleaning methods and materials.
  - Recommendations for redecoration.
  - Ceiling systems intended for fire protection: Limitations placed on subsequent alterations and maintenance procedures, to ensure that their fire performance is not impaired.
  - Maximum number, position and value of point loads that can be applied to ceiling system after installation.

530 SPARES

- General: At Completion supply the following: 25 tiles for each ceiling system unless otherwise indicated by Engineer.

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K41 RAISED ACCESS FLOORS

To be read with Preliminaries/ General Conditions.

TYPES OF RAISED ACCESS FLOOR

120 RAISED ACCESS FLOOR generally

- Standard: To BS EN 12825.
- Subfloor: New screed on concrete slab.
  - Preparation: Apply dustproofing sealer.
- Floor panels: As clause 315.
  - Accessibility: Full.
- Pedestal fixing: Mechanical.
- Structural performance:
  - Static loading requirements:
    Structural load class: Class 5 unless otherwise indicated.
    Deflection class: Class A.
    Safety factor: 2.0.
  - Dynamic loading requirements:
    Absorption of hard body impacts testing: Required.
    Absorption of soft body impacts testing: Required.
    Rolling load testing: To check suitability for Castor wheels.
    - System shall be suitable for heavy-duty rolling loads including server racks and equipment.
- Fire performance: As clause 234.
- Installed mass of system (maximum): Not restricted.
- Height:
  - Finished raised access floor height above subfloor: Determined by floor void height.
  - Floor void height: Determined by finished floor height.
- Acoustic insulation: as clause 239.
- Thermal conductivity (maximum): Not applicable.
- Floor void air leakage: Limited as clause 249.
- Floor covering: Adhered static dissipative vinyl tiles as indicated in manual.
- Refer section M50.
  - Peel resistance of covering: Not required.
- Accessories: Provide all accessories required to install the system complete.

GENERAL/ PERFORMANCE

210 GENERAL PERFORMANCE

- Structural requirement: Generally, as section B50.
  - Additional requirements: None.

219 INSTALLATION

- Completed installation: Clean and stable. Free from bounce and vibration. No lipping between floor panels.

234 FIRE PERFORMANCE

- Reaction to fire: To BS 476-7, class 1.
- Resistance to fire: To BS 476-20 and -21, 30 minutes loadbearing capacity and integrity.

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239 SOUND TRANSMISSION

- Laboratory system test: In accordance with BS EN ISO10848-2.
  - Airborne sound insulation: as indicated in the acoustic report.
  - Impact sound insulation: as indicated in the acoustic report.
  - Test report: Submit.

COMPONENTS

310 SAMPLES

- General: Submit representative samples of the following: Floor panels, pedestals, pads, stringers and all accessories.
  - Purpose: Engineer's Approval.

315A FLOOR PANELS GENERALLY

- Panel size: 600 x 600 mm nominal.
  - Dimensional deviations: To BS EN 12825, Class 1.
- Life expectancy, excluding coverings (minimum): 25 years.
- Casing material: Steel.
  - Casing finish: Galvanized.
  - Casing thickness: As required to meet Class 5 performance.
  - All components shall be free from electro-zinc plating to prevent zinc whisker formation.
- Core material: Cementitious filled steel core material.
- Where indicated on drawings, use Perforated panels top surface with slots of number, spacing, and size standard with manufacturer to produce a nominal open area of 25 percent.
- Perimeter edging material: Steel.
- Weight of removable panels: 20 kg maximum without floor covering.
- Floor panel fixing: gravity -held in under structure for fast removal and replacement and if required, blots.
- Floor panel location method: Positive.
- Labelling:
  - Nonstandard panels: Identify for relocation purposes.
  - Service identification labels: Provide self-adhesive labels to identify under-floor services and their direction. Fix to the visible surface of the floor panel, and under carpet finish if any.

320 PEDESTALS GENERALLY

- Material: Mild steel with galvanized base plates.
- Life expectancy (minimum): 50 years.
- Adjustability: Adjustable.
  - Limits on adjustability: Submit proposals to Engineer's approval.
  - Locking: Required.
- Additional pedestals: Where required.
- Provide seismic-resistant pedestals where required to resist lateral loads and vibrations.

322 PEDESTAL ADHESIVE

- Adhesive: Compatible with subfloor surface finish.

325 STRINGERS GENERALLY

- Type: Submit proposals.
- Material: galvanized steel.
- Life expectancy (minimum): 50 years.
- Removable stringers: Bolted.

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331 INTEGRAL FLOOR PANEL COVERINGS GENERALLY

- Type: Static dissipative or conductive vinyl tiles to BS EN 649.
- Peel resistance (minimum) to BS EN 12825: 0.8 N/mm.
- Floor panel covering edges: Protect.

340 CAVITY BARRIERS

- Type: Mineral wool slabs.
- Performance:
  - General: Permanently stable, continuous, and an effective barrier to smoke and flame.
  - Fire resistance: To BS 476-20 and -22, 30 minutes integrity and insulation.
- Spacing: Maximum dimension in any direction: 10 m.
- Fixing: Fix securely so that their performance is unlikely to be affected by:
  - Movement of the building due to subsidence, shrinkage or temperature change.
  - Failure of their fixings in a fire.
  - Failure in a fire of any abutting material or construction.
  - Collapse in a fire of any services penetrating them.
- Floor panels above cavity barriers: To be firmly secured.
- Gaps between cavity barriers and other elements: Seal with mineral wool or other suitable material.
- Notification: Give notice when cavity barriers have been installed.

390 SUNDRY ACCESSORIES GENERALLY

- Component: Expansion joints and perimeter skirting.
  - Manufacturer: Submit proposals.
    Product reference: Submit proposals.

INSTALLATION

410 CONTROL SAMPLES

- General: Complete areas of finished work in the following locations: 1.5m2 including all accessories where agreed with the Engineer.

421 PREPARATIONS

- Areas where flooring is to be installed: Clean before installation and keep clean during installation.
- Setting out of flooring: Indelibly mark pedestal positions before installing services.
- Fixtures: Before installing floor, complete fixtures that floor panels are to be cut around, or that are to be bridged by floor supports.
- Bridging structures - supplementary supports: Where required, all in accordance with the manufacturer's details.

425 ENVIRONMENTAL CONDITIONS

- General: Dry, well ventilated, not subject to rapid variations or extremes of temperature or humidity.
- RH of air (maximum): 75%.
- Subfloors:
  - Moisture content: Test to BS 8201 using an accurately calibrated hygrometer.
  - RH (maximum): 75%.
  - Temperature (minimum): 5°C.

431 DUSTPROOFING

- Preparation: Surfaces to be sealed must be clean, dry and free from dust, grease and other contaminants.
- Extent of sealing: Concrete and masonry surfaces within raised access floor void.

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- Sealer: Recommended by raised access floor manufacturer. Compatible with materials used to pack and/ or fix pedestals.
  - Colour: Tinted; different tint for each coat.
  - First coat: Apply before pedestals are erected.
  - Second coat: Apply after completion of services and other associated work.

435 CUT FLOOR PANELS

- Size (minimum): Half standard width x half standard length.
- Edges:
  - Burrs and rough edges: Make smooth.
  - Sealing: Seal exposed cut edges of floor panels that have moisture sensitive or combustible cores.

    Sealer: Self-adhesive aluminium foil tape rated class 0 as defined in Building Regulations.

441 RAISED ACCESS FLOOR LEVELS

- Permissible deviations in level:
  - Over set length: ±1.5 mm over 3m.
  - Overall: ±6 mm.

445 PERIMETERS

- Expansion gaps:
  - Size: 10 mm.
  - Location: At abutments.
- Expansion gap filling:
  - Filler type: Resilient closed cell.
  - Filling: Before fixing skirtings and cover strips.

455 LEVEL CHANGES

- Performance:
  - Ramps and steps: Comparable with performance of associated raised access floor.
  - Balustrades: Structural and safety requirements in accordance with BS 6180.

460 UNDER-FLOOR PLENUM AIR BARRIERS

- Material: Rigid or semirigid nonporous sheets with smooth non-dusting surfaces.
- Performance: Permanently stable, continuous and airtight.
- Fixing: Fix securely to subfloor, at joints and as necessary.
- Edges and joints: Seal.

470 INTEGRAL FINISHES ELECTRICAL RESISTANCE TESTING

- Location: Test complete raised access floor.
- Extent of testing: Test complete raised access floor.
- Testing agent: Qualified electrician.

COMPLETION

510 TOOLS

- Floor panel lifting devices: At completion, supply one set of suitable devices for each type of raised access floor finish installed. Train designated personnel in their use.
- Pedestal locking: At completion, supply one set of tools for releasing pedestal locking.

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515 USER INSTRUCTIONS

- User manual contents: Include the following:
  - Correct method for lifting and replacing floor panels and stringers.
  - Limitations on sequence, number and positions of floor panels and stringers that can be removed safely at one time.
  - Permissible loading, with guidance on use of spreader plates when shifting heavy equipment and subsequent maintenance.
  - Methods for installing cabling and ducts to prevent damage to supporting structure.
  - Methods for cleaning floor panels and integral finishes.
  - Method for replacing integral floor panel coverings.
  - Method for adjusting and locking pedestals.
  - Recommended maintenance methods and frequency.
    Minimum maintenance-free life of raised access floor system.
    Minimum maintenance-free life of replaceable parts where this differs from that of the whole system.
    Minimum period during which replaceable components will be available.
  - Installation instructions, including COSHH Assessment.

520 SPARES

- General: At completion, supply the following: s determined by Engineer.

525 CLEANING

- Subfloors: At completion, thoroughly clean accessible areas of subfloors and leave free of dust and debris.
- Raised access floor: Before delivery of items carried by floor, clean thoroughly.

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L10 WINDOWS/ ROOFLIGHTS/ SCREENS/ LOUVRES

To be read with Preliminaries/ General Conditions.

GENERAL

110 EVIDENCE OF PERFORMANCE

- Certification: Provide independently certified evidence that all incorporated components comply with specified performance requirements.

120 SITE DIMENSIONS

- Procedure: Before starting work on designated items take site dimensions, record on shop drawings and use to ensure accurate fabrication.
- Designated items: all items specified hereafter.

140 CONTROL SAMPLES

- Procedure:
  - Finalise component details.
  - Fabricate one of each of the following designated items as part of the quantity required for the project.
  - Obtain approval of appearance and quality before proceeding with manufacturer of the remaining quantity.
- Designated items: all items specified hereafter.

150 DAYLIGHT PERFORMANCE

- Daylight calculations: In accordance with BS 8206-2 and CIBSE 'Lighting guide LG10'.
- BREEAM requirements:
  - Submit: Design plans for each floor in the building with each room/ area labelled for use.
  - Calculations showing: Minimum point daylight factor expressed as a percentage for each room/ area.

PRODUCTS

335A ALUMINIUM WINDOWS

- Standard: To BS 4873.
- Exposure category to BS 6375-1/ Design wind load: 2000 Pa.
- Design wind pressure: Calculate in accordance with: BS EN 1991-1-4 and National Annex.
- Finish as delivered: super durable Polyester powder coating to BS 6496, Qualicoat Class 2, and AAMA 2604.
- Thermal performance (U-value maximum): 1.9 W/m²K for total assembly, considering as well that all frames shall be provided with thermal breaks.
- Glazing details: as section L40.
  - Beading: as indicated on drawings.
- Ironmongery/ Accessories: as indicated on drawings, and as specified in section P21.
- Fixing: Screwed to masonry reveal as clause 782.

650 METAL LOUVRES

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Material: Aluminium 2 mm thick blades.
  - Finish as delivered: super durable Powder coated, Qualicoat Class 2 or AAMA2604.

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- Fire resistance rating: Not applicable.
- Number of louvre banks: One unless otherwise indicated on drawings and depending on weather resistance required.
- Louvre blade pitch and angle: Pitch: 100 mm, unless otherwise recommended by manufacturer.
- Blanking panels: Not required.
- Accessories/ Other requirements:
  Removable section for plant access where indicated on drawings
  Stainless steel bird mesh, unless otherwise indicated on drawings to be aluminium.
  Provide shop drawings for Engineer's approval prior to fabrication
  Provide sealant as section Z22 and as indicated on drawings to seal all gaps in jamb, head and sill
- Louvers to be Class A for excellent rain defence, where indicated on drawings.
- Fixing: as clause 782.

650B SAND TRAP METAL LOUVRES (IF INDICATED ON DRAWINGS)

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Description: Vertical channel louvre blades provide enhanced trapping of small airborne particles, particularly relevant where problems such as windborne sand are expected.
- Louvre blades mounted vertically directly into surrounding box frames to produce an overlapping baffle configuration.
- Collected debris ejected via horizontal Sill slot.
- Material: Aluminium, 2 mm thick blades.
  - Finish as delivered: super durable Powder coated, Qualicoat Class 2 or AAMA2604.
- Fire resistance rating: Not applicable.
- Number of louvre banks: One unless otherwise indicated on drawings and depending on weather resistance required.
- Louvre blade pitch and angle: Pitch: 100 mm, unless otherwise recommended by manufacturer.
- Blanking panels: Not required.
- Accessories/ Other requirements:
  Stainless steel bird mesh
  Provide shop drawings for Engineer's approval prior to fabrication
- Provide sealant as section Z22 and as indicated on drawings to seal all gaps in jamb, head and sill.
- Fixing: as clause 782.
- Sand efficiency removal: not less than 85% when measured during testing as described in ASHRAE standard 52-76 test method or equivalent as submitted to Engineer's approval.

EXECUTION

710 PROTECTION OF COMPONENTS

- General: Do not deliver to site components that cannot be installed immediately or placed in clean, dry floored and covered storage.
- Stored components: Stack vertical or near vertical on level bearers, separated with spacers to prevent damage by and to projecting ironmongery, beads, etc.

740 CORROSION PROTECTION

- Surfaces to be protected: Aluminium alloys in direct contact with:
  - Iron and steel unless galvanized.
  - Concrete, mortar or plasters, especially when embedded.
- Lead and stainless steel in heavily polluted atmospheres.
- Protective coating: Two coats of bitumen solution to BS 6949 or an approved mastic impregnated tape.

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- Timing of application: Before fixing components.

750 BUILDING IN

- General: Not permitted unless indicated on drawings.
  - Brace and protect components to prevent distortion and damage during construction of adjacent structure.

765 WINDOW INSTALLATION GENERALLY

- Installation: Into prepared openings.
- Gap between frame edge and surrounding construction:
  - Minimum: 3 mm.
  - Maximum: 10 mm.
- Distortion: Install windows without twist or diagonal racking.

766A LOCATION OF OPENABLE WINDOWS, IF REQUIRED AND INDICATED, IN NATURALLY VENTILATED BUILDINGS

- Location: Over 10 m from sources of external pollution.

770 DAMP PROOF COURSES IN PREPARED OPENINGS

- Location: Ensure correct positioning in relation to window frames. Do not displace during fixing operations.

782 FIXING OF ALUMINIUM FRAMES

- Standard: As section Z20.
- Fasteners: 10 mm phosphor bronze expanding bolts unless otherwise indicated on drawings and as recommended by Manufacturer to Engineer's approval.
  - Spacing: When not predrilled or specified otherwise, position fasteners not more than 250 mm from ends of each jamb, adjacent to each hanging point of opening lights, and at maximum 600 mm centres.

790 FIRE RESISTING FRAMES

- Gap between back of frame and reveal: Completely fill with intumescent mastic or tape and tightly packed mineral wool.

810 SEALANT JOINTS

- Sealant:
  - Manufacturer: Submit proposals to Engineer's approval.
    Product reference: Submit proposals to Engineer's approval.
  - Colour: to Engineer's selection from manufacturer's standard range.
  - Application: As section Z22 to prepared joints. Finish triangular fillets to a flat or slightly convex profile.

820 IRONMONGERIES

- Fixing: In accordance with any third-party certification conditions applicable. Assemble and fix carefully and accurately using fasteners with matching finish supplied by ironmongery manufacturer. Do not damage ironmongery and adjacent surfaces.
- Checking/ Adjusting/ Lubricating: Carry out at Completion and ensure correct functioning.

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L20 DOORS/ SHUTTERS/ HATCHES

To be read with Preliminaries/ General Conditions.

GENERAL

110 EVIDENCE OF PERFORMANCE

- Certification: Provide independently certified evidence that all incorporated components comply with specified performance requirements.

112 TIMBER PROCUREMENT

- Timber (including timber for wood-based products): Obtained from well-managed forests and/ or plantations in accordance with:
  - The laws governing forest management in the producer country or countries.
  - International agreements such as the Convention on International Trade in Endangered Species of wild fauna and flora (CITES).
- Documentation: Provide either:
  - Documentary evidence (which has been or can be independently verified) regarding the provenance of all timber supplied.
  - Evidence that suppliers have adopted and are implementing a formal environmental purchasing policy for timber and wood-based products.
- Certification scheme:
  - Forest Stewardship Council (FSA).
  - Programme for the Endorsement of Forest Certification (PEFC); or
- Sustainable Forestry Initiative (SFI), with Chain of Custody or submit proposals for Engineer's approval.
  - Other evidence: None.

115 FIRE RESISTING DOORS/ DOOR ASSEMBLIES/ DOORSETS

- Door products: As defined in BS EN 12519.
- Evidence of fire performance: Provide certified evidence, in the form of a product conformity certificate, directly relevant fire test report or engineering assessment, that each door/ door assembly/ door set supplied will comply with the specified requirements for fire or smoke resistance if tested to BS 476-22, BS EN 1634-1 or BS EN 1634-3. Such certification must cover door and frame materials, glass and glazing materials and their installation, essential and ancillary ironmongery, hinges and seals.
- Components, assemblies or sets will be marked to the relevant product standard and/ or third-party certification rating.

120 NON-FIRE RESISTING DOORS/ DOOR ASSEMBLIES/ DOORSETS

- Provide certified evidence, in the form of a product conformity certificate or engineering assessment, that each door/ door set/ assembly supplied will comply with the specified requirements to BS EN 14351-1. Such certification must cover door and frame materials, glass and glazing materials and their installation, essential and ancillary ironmongery, hinges and seals.
- Components and assemblies will be marked to the relevant product standard and/ or third-party certification rating.

150 SITE DIMENSIONS

- Procedure: Before starting work on designated items take site dimensions, record on shop drawings and use to ensure accurate fabrication.
- Designated items: all items specified hereafter.

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170 CONTROL SAMPLES

- Procedure:
  - Finalize component details.
  - Fabricate one of each of the following designated items as part of the quantity required for the project.
  - Obtain approval of appearance and quality before proceeding with manufacture of the remaining quantity.
- Designated items: all items specified hereafter.

PRODUCTS

230 WOOD FLUSH DOORS FD30S FIRE RESISTING AND SMOKE CONTROL SINGLE AND DOUBLE LEAF DOORS, WHERE INDICATED ON DRAWINGS

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Facings: hardwood veneer, as indicated in door schedule and drawings, and in compliance with manufacturer's recommendations to meet fire rating required.
- Lipping's: manufacturer's recommended concealed lipping's to long edges to meet fire rating required.
- Preservative treatment: Not required, unless otherwise recommended by manufacturer.
- Finish as delivered: Full factory finish.
- Glazing/ Infill details: where indicated, Clear fire-resisting glazing.
  - Manifestation: As indicated on drawings.
  - Beading: Not required, unless otherwise recommended by Manufacturer.
- Thermal performance (U-value maximum): Manufacturer's standard.
- Other requirements: None.

230A WOOD FLUSH DOORS NON-FIRE RESISTING SINGLE AND DOUBLE LEAF DOORS WHERE INDICATED ON DRAWINGS

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Facings: HPL high pressure laminate.
- Lipping's: manufacturer's recommended lipping's.
- Preservative treatment: Not required.
- Finish as delivered: Full factory finish.
- Glazing/ Infill details: Not applicable.
  - Manifestation: Not required.
  - Beading: Not required, unless otherwise recommended by Manufacturer.
- Thermal performance (U-value maximum): As required to achieve the thermal performance and as indicated in sustainability report.
- Other requirements: None.

270 WOOD DOORS FD30S FIRE RESISTING AND SMOKE CONTROL WHERE INDICATED ON DRAWINGS AND DOOR SCHEDULE

- Materials: Generally, to BS EN 942.
  - Species: Hardwood as table NA2.
  - Appearance class: J20.
- Panels: 6 mm birch faced plywood; Bonding quality to BS EN 314-2: Class 3 unless otherwise recommended by manufacturer to meet fire rating indicated.
- Assembly:
  - Adhesive: PVAC to BS EN 204, Class D4, unless otherwise recommended by manufacturer.

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  - Joinery workmanship: As section Z10.
  - Accuracy: To BS 4787-1.
- Preservative treatment: Organic solvent as section Z12 and WPA Commodity Specification C5; Desired service life: 30 years.
- Moisture content on delivery: 12-16%.
- Finish as delivered: Full paint system, as section M60.
- Glazing/ Infill details: where indicated, to be Clear fire-resisting glazing.
  - Manifestation: As indicated on drawings.
  - Beading: Not required, unless otherwise recommended by Manufacturer.
- Thermal performance (U-value maximum): As required to achieve the thermal performance and as indicated in sustainability report.
- Other requirements: None.

280A DOORS STEEL

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Finish as delivered: Polyester powder coated to BS 6496, colour to be submitted to Engineer's approval.
- Finish system for Exterior steel doors: zinc rich epoxy anti corrosive metal primer and mid coats, factory applied. Solvent based -component aliphatic polyurethane finish coat. Number of coats and Dry film thickness to be in accordance with ISO 12944 and as recommended by manufacturer for category C5 for exterior and C4 for interior. Warranty to first maintenance: not less than 15 years.
- Glazing/ Infill details: Not applicable.
  - Manifestation: Not applicable.
  - Beading: Not required, unless otherwise recommended by Manufacturer.
- Ironmongery: As ironmongery schedule and as specified in section P21.
- Thermal performance (U-value maximum): Manufacturer's standard and comply with sustainability report.
- Other requirements: None.

280B DOORS STEEL AND FIRE RESISTING AND SMOKE CONTROL WITH RESPECT TO RATING INDICATED

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Finish as delivered: unless otherwise indicated, to be Polyester powder coated to BS 6496, colour to be submitted to Engineer's approval.
- Finish system for Exterior steel doors: zinc rich epoxy anti corrosive metal primer and mid coats, factory applied. Solvent based 2-component aliphatic polyurethane finish coat. Number of coats and Dry film thickness to be in accordance with ISO 12944 and as recommended by manufacturer for category C3. Warranty to first maintenance: not less than 15 years.
- Glazing/ Infill details: where indicated on drawings, Clear fire-resisting glazing.
  - Manifestation: As indicated on drawings.
  - Beading: Not required, unless otherwise recommended by Manufacturer.
- Ironmongery: As ironmongery schedule and as specified in section P21.
- Thermal performance (U-value maximum): Manufacturer's standard.
- Other requirements: None.

280C LOUVRED DOORS ALUMINIUM UNLESS OTHERWISE INDICATED TO BE STEEL

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.

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- Finish as delivered: Polyester powder coated to BS 6496, colour to be submitted to Engineer's approval.
- Glazing/ Infill details: Not applicable.
  - Manifestation: As indicated on drawings.
  - Beading: Not required.
- Door Material: Unless otherwise indicated to be steel with powder coating, door to be of extruded aluminium profiles fabricated to form entire door assembly.
- Louvre material: 1.6 mm thick extruded aluminium with blade pitch angle at 45 degrees.
- Finish as delivered: factory applied super durable polyester powder coating to qualicot Class 2, unless otherwise indicated on drawings. Colour to be to Engineer's selection from manufacturer's full RAL colour range.
- Ironmongery: As ironmongery schedule and as specified in section P21.
- Thermal performance (U-value maximum): Manufacturer's standard.
- Other requirements: Provide insect screens on the inner face of the louvred panels. Provide sealant as section Z22 to seal all gaps in jamb, head and sill.

310 WOOD DOOR FRAMES FD30S FIRE RESISTING AND SMOKE CONTROL WHERE INDICATED IN SCHEDULE AND ON DRAWINGS

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Species: Hardwood unless otherwise recommended by manufacturer to meet fire rating indicated.
- Preservative treatment: Not required unless otherwise recommended by manufacturer.
- Finish as delivered: Full factory finish.
- Perimeter seals: Fire and smoke seal as recommended by manufacturer.
- Thermal performance: Manufacturer's standard.
- Fixing: as recommended by manufacturer to meet fire rating indicated.

330 WOOD DOOR FRAMES AND ARCHITRAVES

- Materials: Generally, to BS EN 942.
  - Species: Hardwood as table NA2.
  - Appearance class: J20.
- Assembly:
  - Adhesive: PVAC to BS EN 204, Class D4.
  - Joinery workmanship: As section Z10.
- Preservative treatment: Organic solvent as section Z12 and WPA Commodity Specification C5; Desired service life: 30 years.
- Moisture content on delivery: 12-16%.
- Finish as delivered: Full paint system, as section M60.
- Perimeter seals: Acoustic seal.
- Thermal performance (U-value maximum): manufacturer's standard and comply with sustainability report.
- Fixing: as recommended by manufacturer.

370A DOOR FRAMES STEEL and FIRE RESISTING AND SMOKE CONTROL

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Perimeter seals: Fire and smoke seal, and acoustic seal as indicated on drawings and in schedule.
- Finish as delivered for Interior door frames: Polyester powder coated.

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- Finish system for Exterior steel doors: zinc rich epoxy anti corrosive metal primer and mid coats, factory applied. Solvent based 2-component aliphatic polyurethane finish coat. Number of coats and Dry film thickness to be in accordance with ISO 12944 and as recommended by manufacturer.
- Thermal performance (U-value maximum): Manufacturer's standard.
- Fixing: as recommended by manufacturer.

410 WOOD DOORSETS DOUBLE AND SINGLE FIRE RESISTING AND SMOKE CONTROL AND 40DB SOUND INSULATING, UNLESS OTHERWISE INDICATED IN ACOUSTICS REPORT AND IN FIRE AND LIFE SAFETY REPORT

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Door leaf:
  - Facings: hardwood veneer unless recommended otherwise by Manufacturer.
  - Lipping's: manufacturer's recommended lipping's to long edges and where indicated.
  - Finish as delivered: Full factory finish.
- Frame and architraves:
  - Wood species: as indicated on drawings and in schedule.
  - Finish as delivered: Full factory finish.
- Preservative treatment: Not required unless otherwise recommended by manufacturer.
- Glazing/ Infill details: where indicated.
  - Manifestation: As drawing.
  - Beading: Not required.
- Ironmongery: As ironmongery schedule.
- Perimeter seals: Acoustic seal and fire and smoke seal.
- Thermal performance (U-value maximum): Manufacturer's standard and comply with sustainability report.
- Other requirements: None.
- Fixing: as recommended by manufacturer.

430 WOOD DOORSETS DOUBLE and SINGLE FIRE RESISTING AND SMOKE CONTROL AND 40DB SOUND INSULATING, AS INDICATED IN THE FIRE AND LIFE SAFETY REPORT AND ACOUSTICS REPORT

- Materials: Generally, to BS EN 942.
- Door leaf:
  - Core: Manufacturer's choice to meet fire rating and acoustic requirements.
  - Facings: hardwood veneer following manufacturer's recommendations.
  - Lipping's: manufacturer's choice to meet fire rating and acoustic requirement, along with door's integrity and insulation.
  - Finish as delivered: Full paint system, as section M60.
- Frame and architraves:
  - Wood species: as indicated on drawings and in schedule.
  - Appearance class to BS EN 942: J20.
  - Finish as delivered: Full paint system, as section M60.
- Preservative treatment: Organic solvent as section Z12 and WPA Commodity Specification C5; Desired service life: 30 years.
- Glazing/ Infill details: as indicated on drawings.
  - Manifestation: As drawing.
  - Beading: as recommended by manufacturer.
- Moisture content on delivery: 12-16%.
- Ironmongery: As ironmongery schedule.

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- Perimeter seals: Fire and smoke seal as recommended by manufacturer.
- Thermal performance (U-value maximum): Manufacturer's standard and comply with sustainability report .
- Fixing: as recommended by manufacturer.

480A DOORSETS - STEEL; - DOUBLE FIRE RESISTING AND SMOKE CONTROL; AND - 40DB SOUND INSULATING AS INDICATED IN ACOUSTICS REPORT AND AS PER FIRE RATING INDICATED

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Door leaf: powder coated galvanized steel.
  - Finish as delivered: Polyester powder coated for internal steel doors.
  - Finish system for Exterior steel doors: zinc rich epoxy anti corrosive metal primer and mid coats, factory applied. Solvent based 2-component aliphatic polyurethane finish coat. Number of coats and Dry film thickness to be in accordance with ISO 12944 and as recommended by manufacturer.
- Frame and architraves: galvanized steel.
  - Finish as delivered: Polyester powder coated. Where indicated for exterior applications, steel doors to receive polyurethane coating system in compliance with ISO 12944-5, C3. Warranty to first maintenance: not less than 15 years.
- Glazing/ Infill details: Clear fire-resisting glazing where indicated on drawings.
  - Manifestation: As drawing.
  - Beading: Not required.
- Ironmongery: As ironmongery schedule.
- Perimeter seals: Acoustic seal and fire and smoke seal.
- Thermal performance (U-value maximum): Manufacturer's standard and comply with sustainability report.
- Other requirements: None.
- Fixing: as recommended by manufacturer.

495A AUTOMATIC SLIDING DOORS

- Size: as indicated on drawings.
- Arrangement: Opening both sides.
- Profile:
  - Type: Lightweight profile.
- Colour/ Finish: super durable polyester powder coating.
- Glazing: insulating laminated safety glazing, in accordance with section L40.
- Drive unit:
  - Type: to sustain door leaf weight (maximum): 1 x 450 kg, 2 x 300 kg.
  - Sensors:
    Activation: Active infrared and Radar.
    Safety facility: Combined detector and alarm.
- Accessories:
  - Electromechanical lock (bistable lock) with feedback.
  - Emergency 'OFF' switch flush mounted.
  - Monitored battery module; and
- User interface with six operating modes and fault display.

520A SLIDING DOORS GENERALLY

- Manufacturer: Contractor's choice.

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  - Product reference: Submit proposals.
- General: All sections to be extruded from aluminium alloy specification 6060/6063 T6 complying with BS EN 755-9:2001. Aluminium profiles to be manufactured to BS EN 1509001/9002.
- The fabricated product to conform with BS 4873.
- The glass/framing sections to withstand the design wind loading calculated in accordance with BS 63099 pt2: 1995.
- System: Thermally broken outer frame sections mounted on a formed 4mm thick aluminium cill with welded stopped ends. Thermally broken glazing sections bonded to structurally calculated insulating glass units.
- Standard glazing details: Hermetically sealed double-glazed units to BS6262, BS EN 12600, BS5713 with black spacer bars and a P.I.B primary seal and silicone backing seal 32/34mm thick with a 16mm Air filled cavity.
- Glass Incorporating: An outer pane of 10, 12 or 15mm toughened float glass and an inner pane of 6 or 8mm toughened soft coat low-E glass.
- Glass to be toughened to BS EN 12150.
- Ironmongery and fittings: 75mm stainless steel rollers with needle bearings mounted in an enclosed carrier case. 300mm long stainless steel ‘D’ handles on purpose made steel brackets.
- Fully rust proofed deadlock operated by Euro cylinder.
- Arrangement: Paired leaf bottom rolling.
- Ironmongery and fittings: 75mm stainless steel rollers with needle bearings mounted in an enclosed carrier case. 300mm long stainless steel ‘D’ handles on purpose made steel brackets.
- Operation: Manual.
- Other requirements: None.

610 ROLLER SHUTTERS/ CURTAINS ALUMINIUM

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
    Performance: Doors to comply with BS EN 12604 (mechanical aspects) and BS EN 12453 (requirements for safety in use of power operated doors) with third party certification by recognised testing authority. Wind pressure to BS EN 12424: Doors to achieve a minimum wind class of Class 3.
- Arrangement: Vertical roller shutter.
- Shutter/ curtain material: Aluminium.
  - Finish as delivered: anodized unless super durable powder coating is indicated.
- Frame/ Guides: 2 mm thick galvanized steel side guides, complete with articulated wind lock and integral brush seal.
  - Finish as delivered: powder coating.
- Operation: Electrical, with key switch or constant pressure button control, as indicated.
- Ironmongery: electrical lock; pull handle as specified in section P21.
- Other requirements: Battery back-up unit with emergency hand chain.

610C ROLLER SHUTTERS/ CURTAINS FIRE RATED

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
    Performance: Doors to comply with BS EN 12604 (mechanical aspects) and BS EN 12453 (requirements for safety in use of power operated doors) with third party certification by recognized testing authority.
  - Fire resistance: 120 minutes unless otherwise indicated in fire and life safety report and drawings.
  - Surface spread of flame: as indicated in fire and life safety report and drawings.

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and

- Wind resistance: to resist wind load calculated.
- Wind pressure to BS EN 12424:
  - Doors to achieve a minimum wind class of Class 3.
- Fire performance to DIN 4102:
  - Door section element materials are to meet Class B2.
- Arrangement: Vertical roller shutter.
- Shutter/ curtain material: interlocking slats cold rolled from structural-quality, cold-rolled steel sheets galvanised to BS EN ISO 1461 and BS EN 10143.
  - Finish as delivered: powder coating.
- Frame/ Guides: Galvanized steel side guides, complete with signal coloured plastic protection strips and integral brush seal, fixed with galvanized steel anchor brackets. Galvanized steel height-adjustable brackets with mounting plate.
  - Finish as delivered: powder coating.
- Operation: Electrical, controlled release activated by fire alarm link via audio visual warning unit (FDI). Shutters to receive actuating fusible links that close at temperature measured in degrees as provided by manufacturer and in compliance with fire and life safety report
- Ironmongery: electrical lock; pull handle as specified in section P21.
- Other requirements: Battery back-up unit and emergency hand chain.

630 HATCHES GENERALLY

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Performance: Acoustic control: to meet acoustic ratings indicated in the acoustic report, and Fire resistance: as indicated in the fire and life safety report and on drawings.
- Operation: manual.
- Other requirements: recessed surface to accept tiles or other finishes as indicated on drawings.

630A WATER TANK ACCESS PANEL GENERALLY

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Performance: Air Infiltration: less than 0.01 cfm/sq. foot. Water Penetration: no leakage at 15.05 psf.
- Fabricate access panel units of sizes, type and shape shown on drawings.
- Steel angles and T sections supporting the covers and covers constructed from Stainless steel grade 1.4401 class A4 with polished finish.
- to Comply to BS 4211.
- Fasteners are to be nonmagnetic stainless steel as recommended by manufacturer.
- Equip units with complete ironmongery and hardware sets.
- Operation: manual.
- Other requirements: recessed surface to accept tiles or other finishes, as indicated on drawings.

630B METAL ACCESS PANEL TO WALLS AND CEILINGS GENERALLY

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- 1.2 mm stainless steel frame and 1.2 mm stainless steel door tray class A2, unless otherwise indicated on drawings.
- 1.5 mm galvanized steel frame and door tray as indicated on drawings for fire rated wall panels, to receive zinc rich epoxy primer, mid coat and polyurethane topcoat.
- Type: Hinged – fire resisting.
- Joist opening size: as indicated on drawings.

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- Performance:
  - Fire resistance: fire tested up to 2 hours, unless otherwise indicated in fire report and in accord with adjacent fire rated walls, to BS EN 1634-1 or to BS 476-22.
  - Thermal Insulation: Mineral wool insulation
  - Air Infiltration: Airtight to Part L. BS EN 12207: 2000 & BS EN 1026
- Rw32dB acoustic performance, unless otherwise indicated and required in the acoustic report. To BS EN ISO 140-3, BS 2750: Part 3.
- Operation: manual.
- Lock type: security lock: operated by a castellated key.
- Other requirements: recessed surface to accept tiles or other finishes as indicated on drawings.
- Frame type: beaded frame: for installation into unfinished walls or ceilings. Taped and jointed or plaster skimmed over to give a frameless finish.

630C INSULATED ACCESS HATCHES GENERALLY

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Aluminium thermally broken access hatch to permit easy movement of maintenance personnel, tools and equipment.
- Material: 2.3 mm aluminium.
- Insulation: 75 mm polyisocyanurate to cover and curb.
- Lift Mechanism: Maintenance free compression springs located within inner and outer tube.
- Performance: Wind resistance/ air tightness: shall withstand 1.9-kPa external and 0.95-kPa internal loads.
- Operation: manual.
- Other requirements: recessed surface to accept tiles or other finishes as indicated on drawings.

630E ACCESS HATCHES GENERALLY

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Galvanized steel watertight access hatch to permit easy movement of maintenance personnel, tools and equipment.
- Material: 8 mm hot dip galvanized steel sheet coated with zinc rich epoxy primer, epoxy mid coat and polyurethane topcoat as recommended by manufacturer. Use 3 mm thick galvanized steel sheet for door lids for access hatches with no loads acting on them.
- Lift Mechanism: Maintenance free hydraulic pistons with hold open arm in open position. Spring-assisted and counterbalanced rise up doors are recommended for custom sizes.
- Performance: Wind resistance/ air tightness: shall withstand 1.9-kPa external and 0.95-kPa internal loads.
- Operation: manual.
- Other requirements: recessed surface to accept paving tiles or other finishes as indicated on drawings.
- Insulation where indicated for access hatch door lids, to be mineral wool insulation

EXECUTION

710 PROTECTIONS OF COMPONENTS

- General: Do not deliver to site components that cannot be installed immediately or placed in clean, dry, floored and covered storage.
- Stored components: Stacked on level bearers, separated with spacers to prevent damage by and to projecting ironmongery, beads, etc.

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730 PRIMING/ SEALING

- Wood surfaces inaccessible after installation: Primed or sealed as specified before fixing components.

740 CORROSION PROTECTION

- Surfaces to be protected:
  - Timber treated with copper, zinc or mercury-based preservatives.
  - Oak, sweet chestnut, Douglas fir and western red cedar, unless well-seasoned.
  - Iron and steel unless galvanized.
  - Concrete, mortar, plasters or soil, especially when embedded.
  - Paints containing copper or mercury-based fungicides, graphite or Lead.
- Lead and stainless steel in heavily polluted atmospheres.
- Protective coating: Two coats of bitumen solution to BS 6949 or an approved mastic impregnated tape.
  - Timing of application: Before fixing components.

750 FIXING DOORSETS

- Timing: After associated rooms have been made weathertight and the work of wet trades is finished and dried out.

760 BUILDING IN

- General: Not permitted unless indicated on drawings.

770 DAMP PROOF COURSES ASSOCIATED WITH BUILT IN WOOD FRAMES

- Method of fixing: To backs of frames using galvanized clout nails.

780 DAMP PROOF COURSES IN PREPARED OPENINGS

- Location: Correctly positioned in relation to door frames. Do not displace during fixing operations.

790 FIXING OF WOOD FRAMES

- Spacing of fixings (frames not predrilled): Maximum 150 mm from ends of each jamb and at 600 mm maximum centres.

800 FIXING OF LOOSE THRESHOLDS

- Spacing of fixings: Maximum 150 mm from each end and at 600 mm maximum centres.

809 FIRE RESISTING/ SMOKE CONTROL DOORS/ DOORSETS/ ROLLER SHUTTERS/ CURTAINS

- Installation: By a firm currently registered under a third-party accredited fire door installer scheme in accordance with instructions supplied with the product conformity certificate, test report or engineering assessment.

810 FIRE RESISTING/ SMOKE CONTROL DOORS/ DOORSETS/ ROLLER SHUTTERS/ CURTAINS

- Gaps between frames and supporting construction: Filled as necessary in accordance with requirements for certification and/ or door/ door set manufacturer's instructions.

820 SEALANT JOINTS

- Sealant:
  - Manufacturer: Submit proposals to Engineer's approval.
    Product reference: Submit proposals to Engineer's approval.
  - Colour: as selected by Engineer from manufacturer's standard range.
  - Application: As section Z22 to prepared joints. Triangular fillets finished to a flat or slightly convex profile.

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830 FIXING IRONMONGERIES GENERALLY

- Fasteners: Supplied by ironmongery manufacturer.
  - Finish/ Corrosion resistance: To match ironmongery.
- Holes for components: No larger than required for satisfactory fit/ operation.
- Adjacent surfaces: Undamaged.
- Moving parts: Adjusted, lubricated and functioning correctly at completion.

840 FIXING IRONMONGERIES TO FIRE RESISTING DOOR ASSEMBLIES

- General: All items fixed in accordance with door leaf manufacturer's recommendations ensuring that integrity of the assembly, as established by testing, is not compromised.
- Holes for through fixings and components: Accurately cut.
  - Clearances: Not more than 8 mm unless protected by intumescent paste or similar.
  - Lock/ Latch cases for fire doors requiring > 60 minutes integrity performance: Coated with intumescent paint or paste before installation.

850 LOCATIONS OF HINGES

- Primary hinges: Where not specified otherwise, positioned with centre lines 250 mm from top and bottom of door leaf.
- Third hinge: Where specified, positioned on centre line of door leaf.
- Hinges for fire resisting doors: Positioned in accordance with door leaf manufacturer's recommendations.

860 INSTALLATION OF EMERGENCY EXIT DEVICES

- Standard: Unless specified otherwise, install panic bolts/ latches in accordance with BS EN 1125.

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L30 STAIRS/ LADDERS/ WALKWAYS/ HANDRAILS/ BALUSTRADES

To be read with Preliminaries/ General Conditions.

PRELIMINARY INFORMATION/ REQUIREMENTS

105 CONTRACTOR'S DESIGN GENERALLY

- Design responsibility: Determine section sizes and strengths and type, sizes and numbers of fixings.
- Structural and fire requirements:
  - Generally: As section B50.
  - Modifications: None.
  - Design: Complete the design in accordance with the designated code of practice to satisfy specified performance criteria.
- Functional requirements:
  - BS 4211 for ladders.
  - BS 4592 for industrial type flooring and stair treads.
  - BS 6180 for barriers.
  - BS 9999 for fire safety and management.
  - External walkways to BS 8300.
  - Requirements for fire safety and management to BS 9999.
  - Stairs to BS 5395-2.
- Straight stairs and winders to BS 5395-1.
- Additional requirements: None.
- Design and production information: As Preliminaries.
- Timing of submissions: As Preliminaries.

109 STRUCTURAL DESIGN PROVIDED

- Description: As Preliminaries.
- Requirements:
  - Generally: As section B50.
  - Additional requirements: None.

130 SITE DIMENSIONS

- Procedure: Before starting work on designated items take site dimensions, record on shop drawings and use to ensure accurate fabrication.
  - Designated items: all items specified hereafter.

COMPONENTS

410 STEEL LADDERS GENERALLY

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: to Engineer's approval.
- Standard: To BS 4211.
- Safety hoops: required on all fixed ladders rising 2.2 m or more above ground level or a lower platform unless otherwise indicated on drawings.
- Platforms: as indicated on drawings.
- Finish as delivered: Galvanized to BS EN ISO 1461.
- Other requirements:
  - Applied slip resistant nosing's with visual contrast.
  - Applied slip resistant treatment to rungs; and
  - Joints welded and ground smooth

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- Submit shop drawings and structural calculations to Engineer's approval prior to fabrication.
- Fixing: Bolted to concrete floor edges unless otherwise indicated on drawings.

460B WALKWAYS WHERE INDICATED ON DRAWINGS

- Component material, grade and finish as delivered:
  - Flooring: Proprietary aluminium walkway system to BS EN 516, with slip-resistant surface suitable for wet conditions.
  - Guarding: Aluminium guarding system where required.
  - Edge protection: Minimum 100 mm to BS 8300.
  - Handrails: Aluminium handrails where required.
  - Lower handrail: Not required unless indicated on drawings.
- Workmanship: To section Z11.
  - Execution: Install in accordance with manufacturer's instructions and approved drawings.
  - Fixing: Secure, stable, and true to line and level.
  - Protection: Ensure waterproofing integrity of roof is not impaired.
- Other requirements:
  - Joints and connections mechanically fixed, secure, and free of sharp edges.
  - Installation not to impair roof waterproofing or drainage.
  - Provide manufacturer's warranty minimum 10 years.

550A PURPOSE MADE BALUSTRADES GLASS SUPPORTED BALUSTRADES

- Component material, grade and finish as delivered:
  - Guarding: Minimum 25.52 mm thick clear laminated fully tempered glass (12 + 1.52 PVB + 12) to section L40.
- Lamination: Minimum 1.52 mm thick PVB interlayer.
  - Handrails: Stainless steel 1.4401 A4- satin polished or no handrail, unless otherwise indicated on drawings.
    Lower handrail: Not required.
- Workmanship:
  - Joinery: Not applicable.
  - Metalwork: To section Z11.
- Other requirements: None.
- Fixing: to be determined by Contractor as indicated on drawings and to Engineer's approval.
  - Centres: as indicated on drawings.

560 PROPRIETARY BALUSTRADES STAINLESS STEEL BALUSTRADES WHERE INDICATED ON DRAWINGS

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Component material and finish as delivered:
  - Guarding: Stainless steel 1.4401 - satin polished, unless otherwise indicated on drawings and in manual.
  - Handrails: Stainless steel 1.4401- satin polished unless otherwise indicated on drawings.
    Lower handrail: Not required.
- Other requirements: bolt assemblies to be stainless steel as indicated on drawings
- Submit shop drawings to Engineer's approval.
- Fixing: stainless steel expansion bolts as indicated on drawings.
  - Centres: as indicated on drawings.

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570 PURPOSE MADE HANDRAILS STAINLESS STEEL GRADE A4/1.4401

- Component material, grade and finish as delivered:
  - Handrails: Stainless steel - satin polished grade A4, unless otherwise indicated on drawings.
    Lower handrail: Not required.
  - Brackets: Stainless steel - satin polished unless otherwise indicated on drawings and in manual.
- Workmanship:
  - Joinery: Not applicable.
  - Metalwork: To section Z11.
- Other requirements: Submit shop drawings to Engineer's approval.
- Fixing: stainless steel expansion bolts. Submit shop drawings to Engineer's approval.
  - Centres: as indicated on drawings.

580 PROPRIETARY HANDRAILS GALVANIZED STEEL HANDRAILS

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Component material and finish as delivered:
  - Handrails: Low carbon steel - galvanized. Minimum mass Z 275.
    Lower handrail: only where indicated on drawings.
  - Brackets: Stainless steel.
- Other requirements: Submit shop drawings to Engineer's approval.
- Fixing: Anchor fixed to concrete unless otherwise indicated on drawings. Submit shop drawings to Engineer's approval.
  - Centres: as indicated on drawings.

590 APPLIED STAIR NOSINGS WHERE INDICATED ON DRAWINGS

- Standard: In accordance with BS 8300.
- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Material: cast iron nonslip nosing anchored to concrete step as indicated on drawings.
- Size – outer dimensions (rise x going): As indicated on drawings.
  - Profile: radiused edge nosing unless otherwise indicated on drawings.
  - Slip resistance value – water wet (minimum): Rz of 30 μm to BS 1134.
- Colour:
  - Channel/ Frame: epoxy coated cast metal.
  - Inserts: LRV to BS 8493 contrast of 30 (minimum) with tread/ riser.
- Accessories: Edge sealant as manufacturer's recommendations.

592 TRIMS/ EDGINGS TO STAIRS WHERE INDICATED ON DRAWINGS

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Material: Mill finish aluminium.
  - Slip resistance value – water wet (minimum): Rz of 30 μm to BS 1134.
- Size – outer dimensions: As shown on drawings.
  - Profile: Square unless otherwise indicated on drawings.
- Colour:
  - Channel/ Frame: Mill finish.
  - Inserts: LRV to BS 8493 contrast of 30 (minimum) with tread/riser.
- Accessories: Edge sealant as manufacturer's recommendations.
- Other requirements: None.

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INSTALLATION

620 PRIMING/SEALING/PAINTING

- Surfaces inaccessible after assembly/installation: Before fixing components, apply full protective/decorative treatment/coating system.

630 CORROSION PROTECTION OF DISSIMILAR MATERIALS

- Components/ substrates/ fasteners of dissimilar materials: Isolate using washers/ sleeves or other suitable means to separate materials to avoid corrosion and/ or staining.

640 INSTALLATION GENERALLY

- Fasteners and methods of fixing: To section Z20.
- Structural members: Do not modify, cut, notch or make holes in structural members, except as indicated on drawings.
- Temporary support: Do not use stairs, walkways or balustrades as temporary support or strutting for other work.
- Applied finishes: Substrates to be even, dry, sound and free from contaminants. Make good substrate surfaces and prepare/ prime as finish manufacturer's recommendation before application.

670 INSTALLATION OF TREAD INSERTS/ NOSINGS

- Treads: Fully cured, sound and level.
- Fixing:
  - Location/ position: as indicated on drawings and in accordance with BS 8300.
  - Fixings: Stainless steel screws unless otherwise indicated on drawings.
    Centres: As manufacturer's recommendations.

COMPLETION

910 INSPECTION

- Timing: Two weeks prior to date when Contractor expects work to be practically complete and as coordinated with Engineer.
- Period of notice (minimum): 5 working days as coordinated with Engineer.

915 SLIP RESISTANCE TESTING

- Surfaces to be tested: all surfaces specified ditto.
  - Surface condition: Dry and wet.
- Timing: As agreed with Engineer.
- Period of notice (minimum): 5 working days unless otherwise determined by Engineer.
- Test standard: To BS 1134.
  - Testing authority: An approved laboratory.
  - Witnessing/ Certification: Arrange for tests to be witnessed/ certified by: Engineer.
  - Report: Submit.
    Format: As required under BS 1134.

920 DOCUMENTATION

- Contents:
  - Copies of structural design calculations/ test reports.
  - General product information.
  - Installation information.
  - Inspection and maintenance reports.
- Number of copies: as determined by Engineer.
- Submission: as determined by Engineer.

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L35 FIXED UTILITARIAN ACCESS SYSTEMS

To be read with Preliminaries/ General Conditions.

GENERAL

130 LADDER SYSTEM GALVANIZED STEEL LADDER WITH SAFETY CAGE, UNLESS OTHERWISE INDICATED ON DRAWINGS

- Method of provision: Fabricated off site and assembled on site.
- Dimensions: As indicated on drawings.
- Basic component material: Galvanized carbon steel.
- Rungs: Hollow tube unless otherwise indicated on drawings.
- Stiles: Rectangular hollow section unless otherwise indicated on drawings.
- Landings/ platforms: Not required.
- Hoops: Not required.
- Assembly connectors: Stainless steel bolt assemblies and Full welds, unless otherwise indicated on drawings.
- Fixing to superstructure: Stainless steel bolts and Expanding bolts as indicated on drawings.
- Accessories: Brackets for fall arrest system, as section N25 unless indicated otherwise on drawings.

130A ROOF ACCESS GALVANIZED STEEL LADDERS

- Space siderails: As indicated on drawing.
- Siderails: Continuous, 10-by-65-mm steel flat bars, with eased edges.
- Rungs: 19-mm diameter, steel bars.
- Fit rungs in centreline of siderails; plug-weld and grind smooth on outer rail faces.
- Provide nonslip surfaces on top of each rung, either by coating rung with aluminium-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminium-oxide grout.
- Nonslip Surfaces for Steel Ladders: Provide nonslip surfaces on top of each rung by coating with abrasive material metallically bonded to rung.
- Source Limitations: Obtain nonslip surfaces from single source from single manufacturer.
- Provide platforms as indicated fabricated from welded or pressure-locked steel bar grating, supported by steel angles. Limit openings in gratings to no more than 12 mm in least dimension.
- Support each ladder at top and bottom and not more than 1500 mm o.c. with welded or bolted steel brackets.
- Hot dip Galvanize ladders, including brackets.
- Coated with Polyurethane coating.
- Fixing to superstructure: Stainless steel bolts and Expanding bolts as indicated on drawings.
- Accessories: Brackets for fall arrest system, as section N25 unless indicated otherwise on drawings.

170 GUARDING SYSTEM TO LADDERS, STAIR AND WHERE INDICATED ON DRAWINGS

- Method of provision: Fabricated off site and assembled on site.
- Dimensions: As indicated on drawings.
- Basic component material: Galvanized carbon steel.
- Standards: Tubes.
- Handrails: Tubes.
- Knee rails: Tubes.
- Infill panels: Not required.
- Assembly connectors: Stainless steel bolts and screws, unless otherwise indicated on drawings.
- Fixing to parent structure: Stainless steel bolts unless otherwise indicated on drawings.
- Accessories: Brackets for fall restraint system unless otherwise not required as per drawings.

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SYSTEM PERFORMANCE

212 CONTRACTOR'S DESIGN FOR ITEMS SPECIFIED DITTO

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- Design responsibility: Determine section sizes and strengths and type, sizes and numbers of fixings.
- Structural requirements: Contractor to submit shop drawings including structural calculations for Engineer's approval.
  - Generally: As section B50.
    Modifications: Requirements for load testing to BS 5395-2.
  - Design: Complete in accordance with the designated code of practice to satisfy specified performance criteria.
- Functional requirements: Ladders: To BS 4211.
- Additional requirements: None.
- Design and production information: As Preliminaries.
- Timing of submissions: as determined by Engineer.
- Proposals: Submit drawings, technical information, calculations and manufacturers' literature.

214 **COMPLETION** OF DESIGN FOR ITEMS SPECIFIED DITTO

- Requirement: Complete the detailed design to satisfy specified performance criteria and coordinate with the detailed design of related and adjacent work.
  - Standards:
  - BS 8300.
  - Ladders: To BS 4211.
- Requirements for fire safety and management: To BS 9999.
- Structural requirements: Submit shop drawings and structural calculations for Engineer's approval.
  - Generally: As section B50.
    Modifications: Requirements for load testing to BS 5395-2.
  - Design: Complete in accordance with the designated code of practice to satisfy specified performance criteria.
- Additional requirements: None.
- Design and production information: As Preliminaries.
- Timing of submissions: as determined by Engineer.

PRODUCTS

330 LADDERS

- Standard: In accordance with BS 5395-3.
- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.

370 GUARDINGS

- Standard: To BS EN 516.
- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.

420 CARBON STEEL COMPONENTS

- Material: To BS EN 10025-1 and -2 or BS EN 10210-1 as appropriate.
  - Grade: S275JR.
  - Options: 2 and 5.
- Solid floor and tread plates: To BS 4592-5.
  - Thickness: 6 mm unless otherwise indicated on drawings.

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- Expanded metal grating panels: To BS 4592-2.
- Open bar gratings: To BS 4592-1.
  - Depth: 30 mm unless otherwise indicated on drawings.
- Finish: Hot dip galvanized.
  - Colour: Self finished.
- Fixings: As section Z20.

490 ANCHORS

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Material and finish: Stainless steel sleeves and bolts.
- Size: As indicated on drawings.

FABRICATION

510 FABRICATION GENERALLY

- Shop drawings: Submit.

EXECUTION

620 EXECUTION GENERALLY

- Structural members: Do not subject to nonbenign loading. Do not modify, cut, notch or make unspecified holes.
- Frameworks: Assemble and brace, including temporary members required for installation.
  - Temporary support: Do not use access systems as temporary support or strutting for other work.
- External durability of fastenings: Corrosion resistant material or with a corrosion resistant finish.
- Bolted joints:
  - Contact between dissimilar metals: Avoid.
  - Bolts and washers: Select types, sizes and quantities of fasteners or packings and spacings to retain supported components without distortion or loss of support.
- Welded joints:
  - Standards:

    Aluminium alloys: TIG or MIG welding to BS EN 1011-4.
    Carbon steel: Metal arc welding to BS EN 1011-1 and -2.
    Stainless steel: TIG welding to BS EN 1011-3.
  - Surfaces to be jointed: Clean.
  - Tack welds: Use only for temporary attachment.
  - Traces of flux residue, slag and weld spatter: Remove.
  - Surface of welds: Grind smooth.
  - Joints: Fully bonded with no holes of cracks.
- Finished components:
  - Free: From distortion, cracks, burrs and sharp arises.
  - Corner junctions of identical sections: Mitre.
  - Handrails: Smooth and continuous, with no sharp edges.

660 ANCHORING

- Fixing positions: Coordinate location of holding down bolts and wall fixings with services fixing positions.
- Edge distance and spacing (minimum): Submit proposals to Engineer's approval.

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COMPLETION

910 CLEANING

- General: Clean surfaces and wipe down finishes.

920 INSPECTION

- Notice for inspection (minimum): 5 days as determined by Engineer.

930 DOCUMENTATION

- Operation and maintenance instructions: Submit.
- Record drawings: Submit.

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L40 GENERAL GLAZING

To be read with Preliminaries/ General Conditions.

GENERAL REQUIREMENTS

111 PREGLAZING

- Preglazing of components: Permitted.
- Prevention of displacement: Submit details of precautions to be taken to protect glazing and compound/ seals during delivery and installation.
- Defective/ displaced glazing/ compound/ seals: Reglaze components in situ.

140 MATERIAL SAMPLES

- Representative samples of designated materials: Submit before cutting panes.
  - Sample size (minimum): 600 x 300 mm unless otherwise directed by Engineer.
  - Designated materials: glass panes as directed by Engineer.

150 WORKMANSHIP AND POSITIONING GENERALLY

- Glazing generally: In accordance with BS 6262 series.
- Integrity: Glazing must be wind and watertight under all conditions with full allowance made for deflections and other movements.
- Dimensional tolerances: Panes/ sheets to be within ± 2 mm of specified dimensions.
- Materials:
  - Compatibility: Glass/ plastics, surround materials, sealers, primers and paints/ clear finishes to be used together to be compatible. Avoid contact between glazing panes/ units and alkaline materials such as cement and lime.
  - Protection: Keep materials dry until fixed. Protect insulating glass units and plastics glazing sheets from the sun and other heat sources.

151 PREPARATION

- Surrounds, rebates, grooves and beads: Cleaned and prepared by others.

152 PREPARATION

- Surrounds, rebates, grooves and beads: Clean and prepare before installing glazing; ensure compliance with any certified installation requirements.

155 GLASS GENERALLY

- Standards: To BS 952 and relevant parts of:
  - BS EN 572 for basic soda lime silicate glass.
  - BS EN 1096 for coated glass.
  - BS EN 1748-1 for borosilicate glass.
  - BS EN 1748-2 for ceramic glass.
  - BS EN 1863 for heat strengthened soda lime silicate glass.
  - BS EN 12150 for thermally toughened soda lime silicate safety glass.
  - BS EN 12337 for chemically strengthened soda lime silicate glass.
  - BS EN 13024 for thermally toughened borosilicate safety glass.
  - BS EN ISO 12543 for laminated glass and laminated safety glass.
- Panes/ sheets: Clean and free from obvious scratches, bubbles, cracks, rippling, dimples and other defects.
  - Edges: Generally undamaged. Shells and chips not more than 2 mm deep and extending not more than 5 mm across the surface are acceptable if ground out.

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165 HEAT SOAKING OF THERMALLY TOUGHENED GLASS

- Standard: To BS EN 14179.
  - Holding period (minimum): 2 hours. For critical locations including but not limited to overhead canopies and skylights, use 8 hours.
  - Mean glass temperature: 290° ± 10°C.
- Certified evidence of treatment: Submit.
- Designated locations: where indicated on drawings.

180 BEAD FIXING WITH PINS

- Pin spacing: Regular at maximum 150 mm centres, and within 50 mm of each corner.
- Exposed pin heads: Punched just below wood surface.

181 BEAD FIXING WITH SCREWS

- Screw spacing: Regular at maximum 225 mm centres, and within 75 mm of each corner.

190A GLASS TO GLASS JOINTING

- Sealant: Silicone.
  - Standard: To BS EN ISO 11600 and BS EN 15651-2.
    Class: G-20LM.
  - Colour: Clear.
- Fire resistance rating, where indicated:
  - Standard: To BS 476-22.
  - Requirement: 60 minutes integrity and 60 minutes insulation, unless rating is otherwise indicated in the fire and life safety report.
- Joints:
  - Width: Consistent and suitable to receive sealant.
  - Gap between panes: Completely filled, leaving no voids or bubbles.
  - Surplus sealant: Removed to leave a clean, neatly finished weathertight joint.

TYPES OF GLAZING

230 BEAD FIXED SINGLE GLAZING WHERE INDICATED FOR INTERIOR GLASS PARTITIONS

- Pane material: Clear laminated safety glass.
- Surround/ bead: Aluminium.
  - Preparation: Sealant primer unless otherwise recommended by manufacturer.
  - Bead location: Inside and outside, unless otherwise indicated on drawings.
  - Bead fixing: stainless steel screws.
- Glazing compound: Two part rubberizing compound.
- Thermal performance (U-value maximum): Unrated.
- Glazing installation:
  - Glass: Located centrally in surround using setting and location blocks and distance pieces.
  - Finished thickness of back bedding after inserting glazing (minimum): 3 mm.
  - Front bedding: Applied to fill voids.
  - Beads: Bedded in glazing compound and fixed securely.
  - Visible edge of glazing compound: Finished internally and externally with a smooth chamfer.

370 BEAD FIXED INSULATING GLASS UNITS WHERE INDICATED ON DRAWINGS

- IGU: As clause 655.
  - Perimeter taping: Do not use.
- Surround/ bead: extruded Aluminium unless otherwise indicated on drawings.

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  - Preparation: Sealant primer unless otherwise recommended by manufacturer and to Engineer's approval.
  - Bead location: Inside and outside unless otherwise indicated on drawings.
  - Bead fixing: as recommended by manufacturer and to Engineer's approval.
- Glazing system: Preformed gasket sections supplied by window manufacturer.
- Thermal performance (U-value maximum): 1.9 W/m²K for the total assembly including glass and frames.
- Glazing installation:
  - Insulating unit: Located centrally in surround using setting and location blocks.
  - Gaskets and beads: Installed as recommended by frame manufacturer.
    Gasket fit at corners: Tight, without gaps.
  - Drainage and ventilation holes: Unobstructed.

450A SINGLE GLAZING INTO GROOVES GENERALLY

- Pane material: minimum 22 mm with ionoplast laminated safety glass.
- Channel/ surround: powder coated aluminium unless otherwise indicated.
  - Preparation: Sealant primer unless otherwise recommended by manufacturer to the Engineer's approval.
- Beads:
  - Material: Aluminium.
  - Location: Inside and outside unless otherwise indicated on drawings.
  - Preparation: Sealant primer unless otherwise recommended by manufacturer to the Engineer's approval.
  - Fixing: as recommended by manufacturer to the Engineer's approval.
- Glazing system: Filler strip plus sealant capping.
- Glazing installation:
  - Glass: Located centrally in grooves using setting blocks and distance pieces of appropriate thickness.
  - Backing strip: Expanded polyethylene, inserted at head and jambs, ensuring a tight fit and allowing a minimum distance of 6 mm between strip and sight line.
  - Sill beads: Fixed securely with backing strip between bead and glazing.
  - Capping sealant: Applied to fill recesses on both sides of glass and finished to a smooth chamfer.

520 FIRE RATING

- Assessment of capability: Submit proposed construction details of designated items to a UKAS/ EA accredited laboratory or other approved authority for assessment of capability of achieving specified fire ratings.
  - Test standard: To BS 476-22.
- Assessment/ test results and reports: Submit immediately they are available, and before installing glazing.
- Designated items: fire resistant glazing where indicated on drawings.

530 INTERNAL TAPE GLAZING WHERE INDICATED FOR INTERNAL GLAZING

- Pane material: laminated safety glass.
- Surround/ bead: Aluminium.
  - Bead fixing: stainless steel screws.
- Tape/ Section: Extruded rubber.
- Glazing installation: Beads bedded dry to rebate and glazing tape/ section and fixed securely. Tape trimmed flush with sight line on both sides.

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550 GLASS MIRRORS GENERALLY

- Standard: To BS EN 1036.
  - BS EN 1036-2 characteristics: fully tempered.
- Mirror material: Float glass, silvered to give maximum reflection, free from tarnishing, discoloration, scratches and other defects visible in the designed viewing conditions.
  - Thickness: 6 mm unless otherwise indicated on drawings.
  - Backing: Lead foil.
  - Edge treatment: Polished bevel.
- Background: 18 mm thick marine plywood board unless otherwise indicated on drawings.
- Fixing method: Dome top wood screws with polyethylene sleeves and washers at 600 mm centres unless otherwise indicated on drawings.
- Installation: Fixed accurately and securely without overtightening fasteners, to provide a flat surface giving a distortion free reflection.

560 BACK PAINTED GLASS DECORATIVE CLADDING

- General: Provide back painted glass wall cladding as indicated on drawings and finishes manual.
- Thickness: 10 mm toughened glass.
- Glass type: Low iron toughened safety glass with factory applied back paint.
- Standards: Comply with BS EN 12150/ BS EN 12600.
- Finish:
  - Even, opaque colour coating on rear face.
  - Colour and finish as indicated in finishes manual.
- Panels:
  - Sizes and layout as indicated on drawings.
  - All edges polished.
- Fixing: Mechanical supports as recommended by manufacturer.
- Installation:
  - Install plumb, level and aligned with uniform joints.
  - Provide proper backing support and allow for movement.
- Joints:
  - Seal with silicone sealant.
  - Colour as selected.

610 WINDOW FILM AND DECORATIVE GLAZED PARTITION FLIM

- Type: Privacy. Film tensile strength is 25,000 psi. Thickness not less than 200 micrometres. Light transmittance not less than 70%. Window film to comply with BS 476-6 and 7, class 0-surface spread of flame and ignitability. Warranty: 10 years on window film when internally applied by a certified installer..
- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Colour: Neutral unless otherwise indicated on drawings to match selected NCS colour.
- Application: Carried out by a firm approved by the film manufacturer in accordance with manufacturer's recommendations.
  - Evidence of applicator's competence and experience: Submit on request.
  - Sample area: Complete as part of the finished work, in an approved location and obtain approval of appearance before proceeding.
  - Ambient air temperature at time of application: Above 5°C.
- Installed film: Fully adhered to the glass with no peeling, and free from bubbles, wrinkles, cracks or tears.
- Further contact with applied films: Avoid until bonding adhesive has cured.
- Cleaning and maintenance instructions: Submit copies.

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M10 CEMENT BASED LEVELLING/ WEARING SCREEDS

To be read with Preliminaries/General Conditions.

TYPES OF SCREED

110A BONDED CEMENT: SAND LEVELLING SCREEDS to substrate

- Substrate: concrete slab.
- Screed construction: Fully bonded.
- Thickness:
  - Nominal: as indicated but not less than 30 mm.
  - Minimum: 25 mm.
  - Maximum: 40 mm.
  - Provided unbonded screed when thickness exceeds 40 mm.
- Mix:
  - Proportions (cement:sand): To BS 8204-1.
- In situ crushing resistance (ISCR) category: A (3 mm maximum indentation).
- Flatness/ Surface regularity class: SR2.
- Finish: Smooth floated, as clause 530.
  - To receive: finishes indicated in the finish manual.
- Other requirements: Movement joints.

115 CEMENT: SAND LEVELLING SCREEDS generally

- Substrate: reinforced concrete slab.
- Screed construction: as indicated on drawings.
  - Reinforcement for crack control: Steel fabric, as clause 392.
- Thickness:
  - Nominal: Variable to achieve the slopes indicated on drawings.
  - Minimum: 50 mm.
- Mix:
  - Proportions (cement:sand): To BS 8204-1.
- In situ crushing resistance (ISCR) category: A (3 mm maximum indentation).
  - Mass of test weight: 4 kg.
- Flatness/ Surface regularity class: SR2.
- Finish: Smooth floated, as clause 530.
  - To receive: finishes indicated in the finish manual.
- Other requirements: Movement joints.

160 PROPRIETARY SELF SMOOTHING LEVELLING SCREEDS generally

- Substrate: reinforced concrete slab.
- Screed manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Screed construction: Bonded and reinforced with glass fibre mesh.
- Thickness:
  - Nominal: 10 mm.
  - Minimum: 6 mm.
  - Maximum: 25 mm.
- Standards: In accordance with BS 8204-7.
- In situ crushing resistance (ISCR) category: C (2.5 mm maximum indentation).
  - Mass of test weight: 2 kg.

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- Flatness/ Surface regularity class: SR1.
- Finish to receive: finishes indicated in the finish manual.
- Other requirements: None.

195 PROPRIETARY SCREEDS TO BS EN 13813 generally

- Substrate: reinforced concrete slabs.
- Screed manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Screed construction: Fully bonded, as clause 260 unless otherwise indicated.
  - Reinforcement for crack control: fiber glass fibrous reinforcements.
- Performance to BS EN 13813:
  - Compressive strength: C35.
  - Flexural strength: F6.
  - Wear resistance: AR4.
- Thickness:
  - Nominal: 70 mm.
  - Minimum: 50 mm.
- Flatness/ Surface regularity class: SR2.
- Finish: Smooth floated, as clause 530.
  - To receive: finishes indicated in the finish manual.
- Other requirements: Movement joints.

GENERALLY/ PREPARATION

205 DESIGN LIFE OF SCREEDS

- Duration: 50 years.
  - Subject to reasonable wear and tear.
- Location: as indicated.
- Condition of use: Subject to correct loading and traffic usage throughout duration.

210 SUITABILITY OF SUBSTRATES

- General:
  - Suitable for specified levels and flatness/ regularity of finished surfaces. Consider permissible minimum and maximum thicknesses of screeds.
  - Sound and free from significant cracks and gaps.
- Concrete strength: In accordance with BS 8204-1, Table 2.
- Cleanliness: Remove plaster, debris and dirt.
- Moisture content: To suit screed type. New concrete slabs to receive fully or partially bonded construction must be dried out by exposure to the air for minimum six weeks.

215 SURFACE HARDNESS OF SUBSTRATES TO RECEIVE POLYMER MODIFIED WEARING SCREEDS

- General: Substrates must restrain stresses that occur during setting and hardening of wearing screeds.
- Test for surface hardness: To BS EN 12504-2 using a rebound hammer with compliance values as follows:
  - Rebound hammer value (minimum):
    Screed thickness 15 mm or less: 25.
    Screed thickness greater than 15 mm: 30.
- Report: Submit details of areas where substrate surface hardness does not comply with these values.

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220 PROPRIETARY LEVELLING/ WEARING SCREEDS

- General: Materials, mix proportions, mixing methods, minimum/ maximum thicknesses and workmanship must be in accordance with recommendations of screed manufacturer.
- Standard: To BS EN 13813.

250 CONDUITS UNDER FLOATING SCREEDS

- Haunching: Before laying insulation for floating screeds, haunch up in 1:4 cement:sand on both sides of conduits.

251 CONDUITS CAST INTO OR UNDER SCREEDS

- Reinforcement: Overlay with reinforcement selected from:
  - 500 mm wide strip of steel fabric to BS 4483, reference D49, or
  - Welded mesh manufactured in rolls from mild steel wire minimum 1.5 mm diameter to BS 1052, mesh size 50 x 50 mm.
- Placing reinforcement: Mid depth between top of conduit and the screed surface.
  - Width of reinforcement (minimum): 300 mm.
- Screed cover over conduit (minimum): 25 mm.

255 PIPE DUCTS/ TRUNKING

- Preformed access ducts: Before laying screed, fix securely to substrates and level accurately in relation to finished floor surface.

260 FULLY BONDED CONSTRUCTION

- Preparation: Generally in accordance with BS 8204-1.
- Removing mortar matrix: Shortly before laying screed, expose coarse aggregate over entire area of hardened substrate.
- Texture of surface: Suitable to accept screed and achieve a full bond over complete area.
- Bonding coat: Manufacturer's standard.

275 CEMENT SLURRY BONDING

- Slurry type: SBR polymer modified cement.
- Application: Shortly before laying screed, thoroughly wash clean the surface and keep well wetted for several hours. Remove free water then brush in cement slurry bonding coat of creamy consistency.
- Screeding: While slurry is still wet.

280 UNBONDED CONSTRUCTION

- Separation: Lay screed over a suitable sheet dpm or a separating layer.
  - Type: Polyethylene sheet, minimum 125 micrometres thick (500 gauge).
- Installation of separating layer: Lay on clean substrate. Turn up for full depth of screed at abutments with walls, columns, etc. Lap 100 mm at joints.

295A FLOATING CONSTRUCTION (THIN SHEET IMPACT SOUND INSULATION)

- Substrate: Remove projections that may puncture the insulation.
- Type of acoustic underlay: as specified in section K11.
- Insulation:
  - Type: recycled rubber.
  - Installation: Lay on substrate. Turn up for full depth of screed at perimeter abutments. Lap 100 mm at joints and seal with tape.
  - Perimeter: Maintain isolation of screed.

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BATCHING/ MIXING

302 CEMENTS

- Cement types: In accordance with BS 8204-1, clause 5.1.3.

305 AGGREGATES

- Sand: To BS EN 13139.
  - Grading limits: In accordance with BS 8204-1, Table B.1.
- Coarse aggregates for fine concrete levelling screeds:
  - Standard: To BS EN 12620.
  - Designation: 4/10.
- Lightweight aggregates: In accordance with BS 8204-1, Annex A.

306 PROPRIETARY POLYMER MODIFIED SCREEDS

- Cement types: In accordance with BS 8204-3.
- Sand: To BS EN 13139:
  - Grading limits: 0/2 mm (MP) category 1.
- Aggregates: In accordance with BS 8204-3.

307 ADMIXTURES

- Standard: In accordance with BS 8204-1, Table 1.
- Calcium chloride: Do not use in admixtures.

310 BATCHING WITH DENSE AGGREGATES

- Mix proportions: Specified by weight.
- Batching: Select from:
  - Batch by weight.
  - Batch by volume: Permitted on the basis of previously established weight:volume relationships of the particular materials. Use accurate gauge boxes. Allow for bulking of damp sand.

330 MIXING

- Water content: Minimum necessary to achieve full compaction, low enough to prevent excessive water being brought to surface during compaction.
- Mixing: Mix materials thoroughly to uniform consistency. Mixes other than no-fines must be mixed in a suitable forced action mechanical mixer. Do not use a free fall drum type mixer.
- Consistency: Use while sufficiently plastic for full compaction.
- Ready-mixed retarded screed mortar: Use within working time and site temperatures recommended by manufacturer. Do not retemper.

335 IN SITU CRUSHING RESISTANCE (ISCR)

- Standards and category: In accordance with BS 8204-1, table 4.
  - Testing of bonded and unbonded screeds: To Annex D.
  - Testing of floating levelling screeds: To Annex E.

340 ADVERSE WEATHER

- Screeds surface temperature: Maintain above 5°C for a minimum of four days after laying.
- Hot weather: Prevent premature setting or drying out.

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LAYING

345 LEVEL OF SCREED SURFACES

- Permissible deviation: (allowing for thickness of coverings) ±5 mm from datum.

350 SCREEDING TO FALLS

- Minimum screed cover: Maintain at the lowest point.
- Falls: Gradual and consistent.
  - Gradient (minimum): as drawings.

351 SCREEDING TO RAMPS

- Screed cover: Thickness varies, screed to falls of 1 in 12.
- Falls: Gradual and consistent.

355 FLATNESS/ SURFACE REGULARITY OF FLOOR SCREEDS

- Standard: In accordance with BS 8204-1, Table 5.
- Test: In accordance with BS 8204-1, Annex C.
- Sudden irregularities: Not permitted.

365 FLATNESS/SURFACE REGULARITY OF ROOF SCREEDS

- Sudden irregularities: Not permitted.
- Deviation of surface: Measure from underside of a 2 m straightedge (between points of contact), placed anywhere on surface.
  - Permissible deviation (maximum): 6 mm.

375 COMPACTION OF SCREEDS

- General: Compact thoroughly over entire area.
- Screeds over 50 mm thick: Lay in two layers of approximately equal thickness. Roughen surface of compacted lower layer then immediately lay upper layer.

382 STAIR SCREEDS , (where indicated)

- Construction: Fully bonded to treads, risers and landings.
- Risers: Form using fine finish formwork.
- Wearing screed surfaces: Make good with compatible cement:sand mix. Wood float. When hardened remove laitance.

386 COVED IN SITU SKIRTINGS

- Background: Concrete blockwork as F10.
- Mix: In accordance with BS 8204-3, Table 2. Aggregate size adjusted as necessary to suit skirting thickness.
- Construction joint: Form at base.
- Rendering: Apply bonding agent. Render skirting while bonding agent is still wet. Achieve a good bond. Allow each coat to set before applying subsequent coats. Render to true lines with a fine finish and an even consistent appearance.
- Dimensions:
  - Thickness of each coat (maximum): 10 mm.
  - Height: 100 mm.
  - Cove radius: 30 mm.
  - Top edge: Rounded.

392 GENERAL REINFORCEMENT

- Steel fabric: To BS 4483.

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  - Type: D49.
- Installation: In accordance with BS 8204-1.

395 STRIP REINFORCEMENT

- Location: Across day joints.
- Steel fabric: To BS 4483.
  - Type D49.
  - Width of strips: 400 mm.
- Installation: In accordance with BS 8204-1.

405 JOINTS IN LEVELLING SCREEDS GENERALLY

- Laying screeds: Lay continuously using 'wet screeds' between strips or bays. Minimize defined joints.
- Daywork joints: Form with vertical edge.

415 BAY JOINTS IN BONDED WEARING SCREEDS

- Bay sizes:
  - Area (maximum): 20 m².
  - Length: Breadth ratio (maximum): 3:2.
- Location of bay joints: Over construction/ movement joints in substrate slab.

435 FORMED JOINTS IN WEARING SCREEDS

- Temporary forms: Square edged with a steel top surface and in good condition.
- Placing screed: Compact thoroughly at edges to give level, closely abutted joints with no lipping.

440 CRACK INDUCING GROOVES IN LEVELLING SCREEDS

- Groove depth: At least half the depth of screed.
- Cutting grooves: Straight, vertical and accurately positioned. Select from the following:
  - Trowel cut as screed is laid.
  - Saw cut sufficiently early after laying to prevent random cracking.

445 CRACK INDUCING GROOVES IN WEARING SCREEDS

- Groove dimensions:
  - Depth: At least half the depth of wearing screed.
  - Width: 6 mm.
- Cutting grooves: Straight, vertical and accurately positioned. Saw cut sufficiently early after laying to prevent random cracking.

460 STRIP MOVEMENT JOINTS where indicated

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
  - Size: 5 mm.
- Installation: Set securely into screed to exact finished level of floor. Extend joints through to substrate.
  - Secure fixing to substrate: To manufacturer's recommendation.

468 SEALANT MOVEMENT JOINTS WITH METAL EDGINGS where indicated

- Edging material: Stainless steel angle.
  - Size: 75 x 50 x 5 mm as indicated.
  - Bedding: 1:3 cement:sand.
- Installation: Centre over joints in substrate. Set to exact finished level of floor.
  - Secure fixing to substrate: Manufacturer's standard.

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- Joint width: Manufacturer's standard.
- Sealant:
  - Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
  - Colour: Manufacturer's standard colour range.
  - Preparation and application: As section Z22.

476A METAL SECTION MOVEMENT JOINTS where indicated

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
  - Bed fixed, 50 mm maximum joint width, 75 mm visible width, 170 mm overall width, unless otherwise indicated on drawings.
  - Colour of insert: Manufacturer's standard colour range.
- Bedding: 1:3 cement:sand.
- Installation: Centre over joint in substrate. Set to exact finished level of floor.
  - Secure fixing to substrate: Stainless steel screws and washers at 300 mm centres.
- Load bearing capacity: to resist car or foot traffic, as indicated on drawings for each particular location.
- Movement: up to 60 mm (±30 mm), unless otherwise indicated on drawings.

FINISHING/CURING

510 FINISHING GENERALLY

- Timing: Carry out all finishing operations at optimum times in relation to setting and hardening of screed material.
- Prohibited treatments to screed surfaces:
  - Wetting to assist surface working.
  - Sprinkling cement.

530 SMOOTH FLOATED FINISH

- Finish: Even texture with no ridges or steps.

600 POWER GROUND FINISH TO WEARING SCREEDS

- Floating: To an even surface with no ridges or steps. Immediately commence curing.
- Grinding: When concrete is sufficiently hard for sand particles not to be torn from surface, remove 1 - 2 mm from surface to give an even glass-paper texture, free from blemishes and trowel marks.
- Cleaning: Remove dust and wash down. Resume curing without delay.

650 CURING

- General: Prevent premature drying. Immediately after laying, protect surface from wind, draughts and strong sunlight. As soon as screed has set sufficiently, closely cover with polyethylene sheeting.
- Curing period (minimum): Keep polyethylene sheeting in position for: period recommended by screed manufacturer.
- Drying after curing: Allow screeds to dry gradually. Do not subject screeds to artificial drying conditions that will cause cracking or other shrinkage related problems.

670 ROOF SCREEDS

- Protection: Cover screeds during wet weather. When weathertight coverings are laid, screeds must be as dry as practicable.

680 SURFACE SEALER TO WEARING SCREEDS

- Manufacturer: Submit proposals.

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  - Product reference: Submit proposals.
- Preparation: Clean cured screed surface to remove dirt, grease, oil and other surface contaminants.
- Moisture content of screed: As recommended by sealer manufacturer. Test relative humidity in accordance with BS 8203, Annex A if required to verify suitability to receive sealer.
- Application: Evenly to dry surfaces using sufficient coats to form an effective seal but without a glossy finish.

690 SLIP RESISTANCE TESTING OF WEARING SCREEDS

- Test:
  - To BS 7976-1, -2 and -3 using a TRL Pendulum.
  - Make arrangements for test to be witnessed/ certified by: Contract Administrator
- Report: Submit. Include slip resistance values in the wet and dry states.

700 ABRASION TESTING OF WEARING SCREEDS

- Test method: To BS EN 13892-4.

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M12 RESIN FLOORING

To be read with Preliminaries/ General Conditions

TYPES OF FLOORING

110 RESIN FLOORING WHERE INDICATED

- Substrate: New polymer-modified cementitious screed.
  - Preparation: Required.
- Resin flooring system:
  - Manufacturer: Submit proposals.
  - Primer reference: As resin flooring manufacturer's recommendations.
  - Resin flooring reference: polyurethane high build floor coating.
  - Application: 4-6 mm nominal thickness.
  - Colour: As schedule.
  - Surface finish/ treatment: Not required, unless otherwise indicated.
- Flatness/ Surface regularity:
  - Sudden irregularities: Not permitted.
  - Classification of surface regularity to BS 8204-6: SR1.
- Slip resistance: Pendulum test value to BS 7976-2 or in accordance with BS 8204-6, Annex B: 40 (minimum) for wet and dry tests.
- Other requirements: None.

120 RESIN FLOORING WHERE INDICATED

- Substrate: New polymer-modified cementitious screed.
  - Preparation: Required.
- Resin flooring system:
  - Primer and detailing of features: Determined by resin flooring manufacturer/ contractor to adequately resist specified trafficking, loads and conditions.
  - Type: FerFA/ BS 8204-6 type 7 heavy duty flowable flooring.
  - Colour: As schedule.
  - Surface finish/ treatment: Not required.
- Flatness/ Surface regularity:
  - Sudden irregularities: Not permitted.
  - Classification of surface regularity to BS 8204-6: SR1 to 3 mm, SR2 elsewhere.
- Slip resistance: Pendulum test value to BS 7976-2 or in accordance with BS 8204-6, Annex B: 40 (minimum) for wet and dry tests.
- Durability:
  - Activities/ Trafficking: heavy traffic.
  - Materials in contact with flooring: resin flooring to be chemical and high temperature resistant.
  - Processes: as recommended by manufacturer.
  - Standing loads: as recommended by manufacturer.
  - Wheeled conveyors: forklift trucks, trolleys, etc.
- Water/ Vapour resistance: Impervious to water.
- Environmental conditions in service: as indicated on reports.
- Other requirements: None.

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130 FLOORING MATERIALS SPECIFICATION BRE ENVIRONMENTAL ASSESSMENT METHOD (BREEAM) RATING

- Minimum BRE 'Green Guide to Specification Online' rating: As schedule.

PREPARATION OF SUBSTRATES

210 TESTING MOISTURE CONTENT OF SUBSTRATES

- Drying aids: Remove minimum four days prior to test.
- Test: To BS 8203, Annex A using an accurately calibrated hygrometer.
  - Location of readings: Corners, along edges, and at various points over the test area.
- Relative humidity before laying resin flooring (maximum): 75% or less.

220 SURFACE HARDNESS OF SUBSTRATES

- General: Substrates must restrain stresses that occur during setting and hardening of resin.
- Test for surface hardness: To BS EN 12504-2 using a rebound hammer.
- Test results: Submit.
- Areas of non-compliance: Submit remedial proposals.

230 PREPARATION OF SUBSTRATES GENERALLY

- Chases/ Saw cuts: Cut/ break out at skirtings, free edges, movement joints, etc. for termination of resin flooring.
- Blow holes, cavities, cracks, etc: Fill with repair product recommended by resin flooring manufacturer.
- Cleanliness: Remove surface contaminants, debris, dirt and dust.
- Surface texture: Suitable to accept resin flooring and achieve a full bond over the complete area.

LAYING FLOORING

310 WORKMANSHIP

- Operatives:
  - Trained/ Experienced in the application of resin floorings.
  - Evidence of training/ experience: Submit on request.
- Fillers and incorporated aggregates: Thoroughly mix in to ensure wetting. Avoid over-vigorous mixing resulting in excessive air entrainment.
- Scattered aggregates: Broadcast onto wet surface of resin.
  - Appearance: Consistent.
- Curing: Allow appropriate periods between coats and before surface treatments and trafficking/ use.

320 CONTROL SAMPLES

- Complete areas of finished work in the following locations: As drawing.
- Approval of appearance: Obtain before proceeding.

330 PRIMERS

- Application: Even to completely wet, penetrate and seal substrates.
- Coverage per coat (minimum): as recommended by manufacturer.
- Curing period (maximum): 48 hours at 15-20°C before application of resin flooring.

357 TROWEL APPLIED SCREEDED RESIN FLOORING

- Application: Even and thoroughly compacted, of uniform thickness, surface finish and colour.

360 SURFACE ABRADING/ POLISHING

- Surface on completion: Uniform, fine and dust free.

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370 SURFACE GRINDING/ GROUTING/ ABRADING/ POLISHING

- Surface on completion:
  - Grinding: Regular appearance to exposed aggregate and dust free.
  - Grouting: Surface defects filled.
  - Abrading/ Polishing: Uniform, fine and dust free.

380 SURFACE SEALER

- Application: Even to completely wet resin surface.

390 SLIP RESISTANCE TESTING OF FINISHED RESIN FLOORING

- Standard: Pendulum test value to BS 7976-2 or in accordance with BS 8204-6, Annex B.
- Timing: Give notice.
  - Notice period (minimum): 5 days.
- Results: Submit pendulum test values, for both wet and dry states.

400 BOND STRENGTH OF RESIN FLOORING

- Contact surfaces: Substrate and fully cured resin flooring.
- Bond: In accordance with manufacturer's performance data.
- Test: To BS 8204-6, clause 11.4 and BS EN 1542.

410 RESIN SKIRTINGS/ UPSTANDS

- Quality: Render grade resin.
- Colour: As flooring.
- Profile: Radius cove.
- Top edge of skirting/ upstand: Tuck into chase.
- Transition with resin flooring: Abutment at chase in the slab.
- Other requirements: None.

420 FREE EDGES OF RESIN FLOORING

- Transition to abutting floor finishes: Straight and smooth.
- Retention of resin edges: Chamfered edge chase in slab.

430 SEALANT MOVEMENT JOINTS WHERE INDICATED

- Location: Centre over movement joints in substrate.
- Preparation and application: As section Z22.
- Retention of resin edges: Chase in slab.
- Joint width: as recommended by manufacturer.
- Sealant: As recommended by Manufacturer.
  - Colour: as selected by Engineer from manufacturer's full range.

440 STRIP MOVEMENT JOINTS WHERE INDICATED

- Location: Centre over movement joints in substrate.
- Retention of resin edges: Chase in slab.
- Joint width: as indicated.
- Strip:
  - Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
  - Insert: Synthetic rubber.
    Colour: as selected by Engineer from Manufacturer's full range.
  - Fixing: Cast into slab using NSS 60 anchors at 300 mm centres to exact finished level of resin flooring.

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M20 PLASTERED/ RENDERED/ ROUGHCAST COATINGS

To be read with Preliminaries/ General Conditions.

TYPES OF COATING

110A CEMENT: SAND EXTERNAL AND INTERNAL PLASTER, WHERE INDICATED

- Substrate: Concrete blockwork, as section F10 or reinforced concrete as indicated on drawings.
  - Preparation: Spatterdash keying coat.
- Cement: lime: sand mortar:
  - Type: Ready-to-use mortar.
  - Pigment: Not required.
- Undercoats:
  - Mix (cement:sand): 1:4.
  - Do not use lime.
    Cement type: Sulfate resisting where indicated, otherwise contractor to submit choice for Engineer's approval.
  - Thickness (excluding dubbing out and keys): First coat 3–6mm mm (from face of lathing) and second coat 10–14 mm.
- Final coat:
  - Mix (cement:sand): 1:4 unless otherwise recommended by manufacturer.
    Cement type: Sulfate resisting only where indicated on drawings.
    Other requirements: Screen sand through 3 mm mesh sieve.
  - Thickness: 8–11 mm prior to scraping.
  - Finish: Plain. Where indicated on drawings, plaster to receive grooves using PVC plaster channels.
- Accessories: Stainless steel stops and beads for external applications and galvanized steel Z275 for internal applications.
- Provide PVC plastered beads and channels of colour as selected by Engineer from manufacturer's full range.

115 DECORATIVE CONCRETE FLOORING

- System Type: Seamless decorative concrete finish with concrete effect.
- Composition: Cement-based material combined with water-based compounds.
- Application: Multi-layer system consisting of three coats, including a protective top coat suitable for high-traffic and water protection areas.
- Thickness: As per manufacturer’s standard system (typically built-up coating; no fixed 5 mm requirement).
- Finish: Smooth decorative finish with concrete appearance; sheen level (matte to semi-gloss) as per approved sample.
- Slip Resistance: R12 rating for enhanced slip resistance (where applicable).
- Fire Performance: Classified as A2fl-s1.
- Durability: High resistance to abrasion, suitable for high-traffic areas.
- Water Resistance: Protective top coat provides water resistance.
- Colour: Grey, unless otherwise specified.
- Maintenance: Low maintenance; periodic cleaning recommended.

220A MULTICOAT PROPRIETARY PLASTER to concrete surfaces

- Substrate: Reinforced micro silica concrete columns, walls, beams and soffit of slabs.
  - Preparation: As clause 536 (the spatter dash keying mix shall be modified for micro silica containing concrete)..

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- Manufacturer: Submit proposals.
- Undercoats:
  - Product reference: Dry pre-mixed cement/ sand plaster manufactured in factory to the requirements of BS 5492. The plaster is mixed at site with clean potable water and is then spray applied to the selected background.
  - Thickness (excluding dubbing out): 4 to 8 mm.
- Final coat:
  - Product reference: Dry pre-mixed cement/ sand plaster manufactured in factory to the requirements of BS 5492. The plaster is mixed at site with clean potable water and is then spray applied to the selected background.
  - Thickness: 5 to 8 mm to achieve an overall thickness of 13 mm (the overall thickness of plaster to concrete soffits should not exceed 10 mm).
  - Finish: Smooth as clause 777.
- Accessories: Provide proprietary plaster accessories as specified herein.

GENERAL

413 SAMPLES

- General: Provide representative samples of the following: Sands for undercoats and final coat for external render.

418 CONTROL SAMPLES

- Complete sample areas, being part of the finished work, in locations as follows: where indicated.

421 SCAFFOLDING

- General: Prevent putlog holes and other breaks in coatings.

MATERIALS AND MARKING OF MORTAR

430 READY-TO-USE CEMENT GAUGED RENDER MORTARS

- Time and temperature limitations: Use within limits prescribed by mortar manufacturer
  - Retempering: Restore workability with water only within prescribed time limits.

438 CEMENTS FOR MORTARS

- Cement: To BS EN 197-1.
  - Types: Portland cement, CEM I.
    Portland slag cement, CEM II.
    Portland fly ash cement, CEM II.
  - Strength class: 32.5, 42.5 or 52.5.
- White cement: To BS EN 197-1.
  - Type: Portland cement, CEM1.
  - Strength class: 52.5.
- Sulfate resisting Portland cement: To BS EN 197-1.
  - Strength class: 42.5.
- Masonry cement: To BS EN 998-1 and Kitemarked.

440 SAND FOR CEMENT GAUGED MORTARS

- Standard: To BS EN 13139.
  - Grading: 0/2 or 0/4 (CP or MP); Category 2 fines.
- Colour and texture: Consistent. Obtain from one source.

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445 PIGMENT FOR COLOURED MORTARS

- Standard: To BS EN 12878.

450 CHLORIDE CONTENT OF MORTARS

- Chloride content (maximum): 0.1% by dry mass.

492 HAIR REINFORCEMENT

- Manufacturer/ Supplier: Submit proposals.
  - Product reference: Submit proposals.
- Proportions (approximate): 5 kg hair to 1 m^3 of coarse stuff.
- Condition: Clean, free from grease and other impurities. Well teased before adding to the mix.
- Distribution: Evenly throughout with no balling into lumps.
- Storage period for haired mortar (maximum): Four weeks.

495 MIXING

- Render mortars (site prepared):
  - Batching: By volume. Use clean and accurate gauge boxes or buckets.
  - Mix proportions: Based on damp sand. Adjust for dry sand.
  - Lime:sand: Mix thoroughly. Allow to stand, without drying out, for at least 16 hours before using.
- Mixes: Of uniform consistence and free from lumps. Do not retemper or reconstitute mixes.
- Contamination: Prevent intermixing with other materials.

497 COLD WEATHER

- General: Do not use frozen materials or apply coatings on frozen or frost bound substrates.
- External work: Avoid when air temperature is at or below 5°C and falling or below 3°C and rising. Maintain temperature of work above freezing until coatings have fully hardened.
- Internal work: Take precautions to enable internal coating work to proceed without detriment when air temperature is below 3°C.

PREPARING SUBSTRATES

510 SUITABILITY OF SUBSTRATES

- Soundness: Free from loose areas and significant cracks and gaps.
- Cutting, chasing, making good, fixing of conduits and services outlets and the like: Completed.
- Tolerances: Permitting specified flatness/ regularity of finished coatings.
- Cleanliness: Free from dirt, dust, efflorescence and mould, and other contaminants incompatible with coatings.

527 RAKING OUT FOR KEY

- Joints in existing masonry: Rake out to a depth of 13 mm (minimum).
  - Dust and debris: Remove from joints.

531 ROUGHENING FOR KEY

- Substrates: Roughen thoroughly and evenly.
  - Depth of surface removal: Minimum necessary to provide an effective key.

536 SPATTERDASH KEY

- Materials:
  - Cement: To BS EN 197-1.
  - Sand: Clean, coarse.
  - Admixtures: SBR bonding agent, Agrément certified.

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- Mix proportions (cement:sand): 1:1.5-2.
- Consistency: Thick slurry, well stirred.
- Application: Throw onto dampened background and leave rough.
  - Thickness: 3-5 mm.
- Curing: Controlled to achieve a firm bond to substrate.

538 STIPPLE KEY

- Materials:
  - Cement: To BS EN 197-1.
  - Sand: Clean, coarse.
  - Admixture: SBR bonding agent, Agrément certified.
- Mix proportions (cement:sand): 1:1.5–2.
- Consistency: Thick slurry, well stirred.
- Application: Brushed and stippled to form deep, close textured key.
- Curing: Controlled to achieve a firm bond to substrate.

541 BONDING AGENT APPLICATION

- General: Apply evenly to substrate to achieve effective bond of plaster/ render coat. Protect adjacent joinery and other surfaces.

584 RECORD CASTINGS

- Timing: Make castings before commencing repair work, to enable accurate reproductions to be made.
- Items for casting: Obtain instructions.
- Identification: Mark clearly to identify original location.

BACKINGS/ BEADS/ JOINTS

600 ADDITIONAL FRAMING SUPPORTS FOR BACKINGS

- Framing: Accurately position and securely fix to give full support to fixtures, fittings and service outlets.
- Support board edges and perimeters: As recommended by board manufacturer to suit type and performance of board.

624 DAMP PROOF LATHING

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Fixing and sealing accessories: As recommended by damp proof lathing manufacturer.
- Fixing: Secure and firm to provide a continuous, keyed backing for coatings.
- Joints between lathing sheets and junctions with services, windows and other openings: Prevent penetration and bridging of cavity by coatings.
- Ventilation gaps:
  - Bottom of lath: Not required.
  - Top of lath: Not required.
  - Accessories: Preformed slotted stop beads.

630 BEADS/ STOPS FOR INTERNAL USE

- Material: Galvanized steel to BS EN 13658-1.

634 BEADS/ STOPS generally

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.

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- Material: Stainless steel 1.4401 class 316 for external applications and Galvanized steel to BS EN 13658-2 Z275 for internal applications. Where indicated on drawings, PCV channels shall be used to form grooves in facades. PVC channels shall be UV resistant.

636 BEADS/ STOPS FOR EXTERNAL USE

- Material: Stainless steel to BS EN 10088-1, grade 1.4301.

638 ARCH FORM METAL LATHING

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Material: Stainless steel.

640 BEADS/ STOPS GENERALLY

- Location: External angles and stop ends except where specified otherwise.
- Corners: Neat mitres at return angles.
- Fixing: Secure, using longest possible lengths, plumb, square and true to line and level, ensuring full contact of wings with substrate.
  - Beads/ stops for external render: Fix mechanically.
- Finishing: After coatings have been applied, remove surplus material while still wet, from surfaces of beads/ stops exposed to view.

646 CRACK CONTROL AT JUNCTIONS BETWEEN DISSIMILAR SOLID SUBSTRATES

- Locations: Where defined movement joints are not required. Where dissimilar solid substrate materials are in same plane and rigidly bonded or tied together.
- Crack control materials:
  - Isolating layer: Building paper to BS 1521.
  - Metal lathing: Stainless steel ribbed expanded metal.
- Installation: Fix metal lathing over isolating layer. Stagger fixings along both edges of lathing.
- Width of installation over single junctions:
  - Isolating layer: 150 mm.
  - Lathing: 300 mm.
- Width of installation across face of dissimilar substrate material (column, beam, etc. with face width not greater than 450 mm):
  - Isolating layer: 25 mm (minimum) beyond junctions with adjacent substrate.
  - Lathing: 100 mm (minimum) beyond edges of isolating layer.

650A MOVEMENT JOINTS generally

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Installation: Centred over joint in substrate.
  - Fixing: Stainless steel screws.
- Accessories: Acoustic barrier, non-reinforced mass loaded vinyl which resists the passage of sound waves.
- Fire Barrier: provide a minimum of two hours integrity and insulation. System as recommended by manufacturer.

673 PLASTERING OVER CONDUITS/ SERVICE CHASES

- General: Prevent cracking over conduits and other services.
- Services chased into substrate: Isolate from coating by covering with galvanized metal lathing, fixed at staggered centres along both edges.

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INTERNAL PLASTERING

710 APPLICATION GENERALLY

- Application of coatings: Firmly and in one continuous operation between angles and joints. Achieve good adhesion.
- Appearance of finished surfaces: Even and consistent. Free from rippling, hollows, ridges, cracks and crazing.
  - Accuracy: Finish to a true plane, to correct line and level, with angles and corners to a right angle unless specified otherwise, and with walls and reveals plumb and square.
- Drying out: Prevent excessively rapid or localized drying out.

715 FLATNESS/ SURFACE REGULARITY

- Sudden irregularities: Not permitted.
- Deviation of plaster surface: Measure from underside of a straight edge placed anywhere on surface.
  - Permissible deviation (maximum) for plaster not less than 13 mm thick: 3 mm in any consecutive length of 1800 mm.

720 DUBBING OUT

- General: Correct substrate inaccuracies.
- New smooth dense concrete and similar surfaces: Dubbing out prohibited unless total plaster thickness is within range recommended by plaster manufacturer.
- Thickness of any one coat (maximum): 10 mm.
- Mix: As undercoat.
- Application: Achieve firm bond. Allow each coat to set sufficiently before the next is applied. Cross scratch surface of each coat.

725 UNDERCOATS GENERALLY

- General: Rule to an even surface. Cross scratch to provide a key for the next coat.
- Undercoats on metal lathing: Work well into interstices to obtain maximum key.
- Undercoats gauged with Portland cement: Do not apply next coat until drying shrinkage is substantially complete.

742 THIN COAT PLASTER

- Preparation for plasters less than 2 mm thick: Fill holes, scratches and voids with finishing plaster.

747 PROJECTION PLASTER

- Application: Evenly and in one continuous operation between angles and joints.
- Finish: A level open textured surface before finishing manually.

777 SMOOTH FINISH

- Appearance: A tight, matt, smooth surface with no hollows, abrupt changes of level or trowel marks. Avoid water brush, excessive trowelling and over polishing.

EXTERNAL RENDERING

810 APPLICATION GENERALLY

- Application of coatings: Firmly and in one continuous operation between angles and joints. Achieve good adhesion.
- Appearance of finished surfaces: Even and consistent. Free from rippling, hollows, ridges, cracks and crazing.
  - Accuracy: Finish to a true plane, to correct line and level, with angles and corners to a right angle unless specified otherwise, and with walls and reveals plumb and square.

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- Drying: Prevent excessively rapid or localized drying out.

815 FLATNESS/ SURFACE REGULARITY OF RENDERING TO RECEIVE CERAMIC TILES

- Sudden irregularities: Not permitted.
- Deviation of render surface: Measure from underside of a 2 m straight edge placed anywhere on surface.
  - Permissible deviation (maximum): 3 mm.

820 DUBBING OUT FOR RENDERING

- General: Correct substrate inaccuracies.
- Thickness of any one coat (maximum): 16 mm.
  - Total thickness (maximum): 20 mm, otherwise obtain instructions.
- Mix: As undercoat.
- Application: Achieve firm bond. Allow each coat to set sufficiently before the next is applied. Comb surface of each coat.

830 ANCHORED MESH REINFORCEMENT

- Application of first undercoat: Through and round mesh to fully bond with solid substrate.

840 UNDERCOATS GENERALLY

- General: Rule to an even surface. Comb to provide a key for the next coat. Do not penetrate the coat.
- Undercoats on metal lathing: Work well into interstices to obtain maximum key.

856 FINAL COAT - PLAIN FLOATED FINISH

- Finish: Even, open texture free from laitance.

880 CURING AND DRYING

- General: Prevent premature setting and uneven drying of each coat.
- Curing coatings: Keep each coat damp by covering with polyethylene sheet and/ or spraying with water.
  - Curing period (minimum): As the render manufacturer's recommendations.
  - Final coat: Hang sheeting clear of the final coat.
- Drying: Allow each coat to dry thoroughly, with drying shrinkage substantially complete before applying next coat.
- Protection: Protect from frost and rain.

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M22 Sprayed monolithic coatings

To be read with Preliminaries/ General conditions.

TYPES OF COATING

120A SPRAYED FIRE PROTECTION WHERE INDICATED

- Sprayed Fire-Resistive Material: Manufacturer's standard, factory-mixed, dry formulation, complying with indicated fire-resistance design, and mixed with water at Project site to form a slurry or mortar before conveyance and application or conveyed in a dry state and mixed with atomized water at place of application.
- Application:
  - Interior applications: Medium density, Portland cement based, designated for interior use by a qualified testing agency acceptable to authorities having jurisdiction.
  - All exterior applications, and C5 environment classification: High density, Portland cement based, designated for exterior use by a qualified testing agency acceptable to authorities having jurisdiction.
- Bond Strength: Minimum 50 kPa cohesive and adhesive strength based on field testing in accordance with ASTM E736/E736M.
- Density: Not less than density specified in the approved fire-resistance design, in accordance with ASTM E605/E605M:
  - Medium density: Not less than 350 Kg/m3.
  - High density: Not less than 640 Kg/m3.
- Thickness: As required for fire-resistance design indicated, measured in accordance with requirements of fire-resistance design or ASTM E605/E605M, whichever is thicker, but not less than 12 mm.
- Combustion Characteristics: Noncombustible when tested to ASTM E136.
- Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - Flame-Spread Index: 0 or less.
  - Smoke-Developed Index: 0 or less.
- Compressive Strength: Minimum 1000 kPa for medium density, and 3000 kPa for high density in accordance with ASTM E761/E761M.
- Corrosion Resistance: No evidence of corrosion in accordance with ASTM E937/E937M.
- Deflection: No cracking, spalling, or delamination in accordance with ASTM E759/E759.
- Effect of Impact on Bonding: No cracking, spalling, or delamination in accordance with ASTM E760/E760M.
- Air Erosion: Maximum weight loss of 0.00 g/sq. m in 24 hours in accordance with ASTM E859/E859M.
- Fungal Resistance: Treat products with manufacturer's standard antimicrobial formulation to result in no growth on specimens per ASTM G21.
- Sound Absorption (where required): As per acoustic report, but NRC not less than 0.60 in accordance with ASTM C423 for Type A mounting in accordance with ASTM E795.
- Finish: As selected by Engineer from manufacturer's standard finishes
  - Color (where required): As indicated by manufacturer's designations and to match Engineer's sample.

120B AUXILIARY MATERIALS

- Provide auxiliary materials that are compatible with sprayed fire-resistive material and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.

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- Substrate Primers: Primers approved in writing by sprayed fire-resistive material manufacturer and complying with one or both of the following requirements:
  - Primer and substrate are identical to those tested in required fire-resistance design by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
  - Primer's bond strength in required fire-resistance design complies with specified bond strength for sprayed fire-resistive material and with requirements in UL's "Product iQ" online directory or in the listings of another qualified testing agency acceptable to authorities having jurisdiction, based on a series of bond tests in accordance with ASTM E736/E736M.
- Bonding Agent: Product approved in writing by sprayed fire-resistive material manufacturer and complying with requirements in UL's "Product iQ" online directory or in the listings of another qualified testing agency acceptable to authorities having jurisdiction.
- Metal Lath: Expanded metal lath fabricated from material of weight, configuration, and finish required, in accordance with fire-resistance designs indicated and sprayed fire-resistive material manufacturer's written instructions. Include clips, lathing accessories, corner beads, and other anchorage devices required to attach lath to substrates and to receive sprayed fire-resistive material.
- Reinforcing Fabric: Glass- or carbon-fiber fabric of type, weight, and form required to comply with fire-resistance designs indicated; approved and provided by sprayed fire-resistive material manufacturer.
- Reinforcing Mesh: Metallic mesh reinforcement of type, weight, and form required to comply with fire-resistance design indicated; approved and provided by sprayed fire-resistive material manufacturer. Include pins and attachment.
- Sealer (where required): Transparent-drying, water-dispersible, tinted protective coating recommended in writing by sprayed fire-resistive material manufacturer for each fire-resistance design.
- Topcoat (where required): Suitable for application over sprayed fire-resistive material; of type recommended in writing by sprayed fire-resistive material manufacturer for each fire-resistance design.
  - Cement-Based Topcoat: Factory-mixed, cementitious hard-coat formulation for trowel or spray application over SFRM.
  - Water-Based Permeable Topcoat: Factory-mixed formulation for brush, roller, or spray application over applied SFRM.
- Caulk: As per manufacturer recommendations and approved certified system.
- Cornerbead: As per manufacturer recommendations.
- Mix water shall be potable and free from such amounts of mineral or organic substances that would effect application or set of material.

PERFORMANCE REQUIREMENTS

160 RESISTANCE TO FIRE

- Assemblies: Provide applied fire protection, including auxiliary materials, in accordance with requirements of each fire-resistance design and manufacturer's written instructions.
- Fire-Resistance Design: Indicated on Drawings, tested in accordance with ASTM E119 or UL 263; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
  - Steel members are to be considered unrestrained unless specifically noted otherwise.
  - UL design listings must state that the loading was determined by Allowable Stress Design Method or Load and Resistance Factor Design Method. UL design listings requiring a load restriction factor are not allowed.

190 GENERAL PERFORMANCE REQUIREMENTS

- Product shall be non-corrosive.

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- Submit manufacturer's written certification that product contains no asbestos, fiberglass or other manmade mineral fibres.
- Submit copy of manufacturer's ISO 9001 Certification.
- Product shall not contain any Urea-Formaldehyde Resins.

GENERAL REQUIREMENTS

205 WARRANTY

- Full System Warranty: Provide full system warranty in which Manufacturer, contractor and Installer are jointly and severally responsible and agree to repair or replace, without limitations, SFRM system that fails within the specified warranty period.
  - Failure includes but shall not be limited to the following:
    Peeling, debonding, erosion.
    Failure to protect against fire for the specified time.
    Cracking.
    Change in color of finish topcoat.
  - Warranty period for Fire Performance: 15 years from date of Substantial Completion.

210 SURFACES TO BE COATED

- Condition: Structurally sound, dry, frost free, free from contamination by dirt, dust, efflorescence or other deleterious substances, and in a suitable condition to receive specified coatings.

220 ENVIRONMENTAL CONDITIONS

- Environmental Limitations: Do not apply applied fire protection when ambient or substrate temperature is 7 deg Cor lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.
- Ventilation: Ventilate building spaces during and after application of fire protection, providing complete air exchanges in accordance with manufacturer's written instructions. Use natural means or, if they are inadequate, forced-air circulation until fire protection dries thoroughly.

240 SEQUENCE OF WORK

- Hangers, supports, clips, sleeves and other attachments: Securely fixed before application of coating.
- Sprayed coating and sealer coats: Applied and cured before:
  - Installation of ductwork, piping, conduit and other suspended equipment.
  - Application of finishes to adjacent surfaces.

250 DIFFICULT ACCESS AREAS

- Requirement: Identify areas where difficulty of access may prejudice achievement of complete integrity of the coating or application of the specified coating thickness and submit proposals for applying coating to these areas. If necessary, seek advice from the coating manufacturer.

260 PROTECTION FROM OVERSPRAY

- Adjacent areas not to be coated: Protect using suitable shielding/ masking materials that will not damage the surface when removed.

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280 CONTROL SAMPLES

- General: Complete areas of finished work in designated locations. Obtain approval before proceeding.
  - Designated areas: as directed by Engineer.

290 INSPECTIONS

- Surface preparation and coating: Notify proposed starting dates.
- Coating manufacturer: Permit to:
  - Inspect the work in progress.
  - Inspect all quality control records.
  - Take dry coating thickness measurements and samples of coating products.
- Coating manufacturer's directions or requests: Submit proposals.
- Coating manufacturer's inspection reports: Submit copies without delay.

APPLICATION OF COATINGS

350 SPRAYED COATINGS GENERALLY

- Interior applications: Medium density, Portland cement based, designated for interior use by a qualified testing agency acceptable to authorities having jurisdiction.
- All exterior applications, and C5 environment classification: High density, Portland cement based, designated for exterior use by a qualified testing agency acceptable to authorities having jurisdiction.

380 CURING

- Fireproofing shall be free of asbestos, mineral fibers, polystyrene, or other known materials which may be considered hazardous either during mixing, application curing, or chemical release in a fire.

390 EXAMINATION

- All structural steel members to receive SFRM shall be provided with a suitable and compatible corrosion protection system, either by priming or by hot-dip galvanization. Refer to section Z11" for corrosion protection system and project corrosion category.
- Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of the Work and in accordance with each fire-resistance design.
  - Verify that substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, paints, and encapsulants, or other foreign substances capable of impairing bond of applied fire protection with substrates under conditions of normal use or fire exposure.
  - Verify that objects penetrating applied fire protection, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.
  - Verify that substrates receiving applied fire protection are not obstructed by ducts, piping, equipment, or other suspended construction that will interfere with fire protection application.
- Verify that concrete work on steel deck is complete before beginning Work.
- Verify that roof construction, installation of rooftop HVAC equipment, and other related work are complete before beginning Work.
- Conduct tests in accordance with sprayed fire-resistive material manufacturer's written instructions to verify that substrates are free of substances capable of interfering with bond.
- Verify that objects which will penetrate fireproofing such as clips, hangers, support sleeves, etc. are securely

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attached to the substrate.
- Primed and Hot dip galvanized steel must follow the current UL application requirements for bond and/or mechanical attachment.
- Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- Proceed with installation only after unsatisfactory conditions have been corrected.
- Start of SFRM application will be construed as Applicator's acceptance of surfaces and conditions within a particular area.

400 PREPARATION

- Cover other work subject to damage from fallout or overspray of applied fire protection materials during application.
- Before SFRM application, clean substrates of substances that could impair bond of applied fire protection.
  - Schedule cleaning and painting application so dust and other contaminants will not fall on wet, newly fire protected surfaces.
  - Clean and prepare surfaces to be fire protected according to manufacturer's written instructions for each particular substrate condition and as specified.
- Prime substrates where included in fire-resistance design and where recommended in writing by sprayed fire-resistive material manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive applied fire protection.
- For applications visible on completion of Project, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of applied fire protection. Remove minor projections and fill voids that would telegraph through applied fire protection after application.

410 APPLICATION

- Construct applied fire protection assemblies that are identical to fire-resistance design indicated and products as specified, tested, and substantiated by test reports; for thickness, primers, sealers, topcoats, finishing, and other materials and procedures affecting applied fire protection Work.
- Comply with sprayed fire-resistive material manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and apply fire protection; as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.
- Coordinate application of fire protection with other construction to minimize need to cut or remove applied fire protection.
  - Do not begin applying fire protection until clips, hangers, supports, sleeves, and other items penetrating fire protection are in place.
  - Defer installing ducts, piping, and other items that would interfere with applying fire protection until application of fire protection is completed.
- Metal Decks:
  - Do not apply fire protection to underside of metal deck substrates until concrete topping, if any, is completed.
  - Do not apply fire protection to underside of metal roof deck until roofing is completed; prohibit roof traffic during application and drying of fire protection.
- Install auxiliary materials as required, as detailed, and in accordance with fire-resistance design and sprayed fire-resistive material manufacturer's written instructions for conditions of exposure and intended use. For auxiliary materials, use attachment and anchorage devices of type recommended in writing by sprayed fire-resistive material manufacturer.
- Spray apply fire protection to maximum extent possible. After the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by sprayed fire-resistive material manufacturer.
- Extend applied fire protection in full thickness over entire area of each substrate to be protected.
- Install body of applied fire protection in a single course unless otherwise recommended in writing by sprayed

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fire-resistive material manufacturer.

- For applications over encapsulant materials, including lockdown (post-removal) encapsulants, apply fire protection that differs in color from that of encapsulant over which it is applied.
- Where sealers are used, apply products that are tinted to differentiate them from applied fire protection over which they are applied.
- Provide a uniform finish complying with description indicated for each type of applied fire protection material and matching finish approved for required mockups.
- Cure applied fire protection in accordance with sprayed fire-resistive material manufacturer's written instructions.
- Do not install enclosing or concealing construction until after applied fire protection has been inspected, tested, and corrections have been made to deficient applications.
- Finishes: Where indicated and as approved by Engineer, apply fire protection to produce the following finishes:
  - Manufacturer's Standard Finishes: Finish in accordance with manufacturer's written instructions for each finish selected.
  - Spray-Textured Finish: Finish left as spray applied with no further treatment.
  - Rolled, Spray-Textured Finish: Even finish produced by rolling spray-applied finish with a damp paint roller to remove drippings and excessive roughness.
  - Skip-Troweled Finish: Even leveled surface produced by troweling spray-applied finish to smooth out the texture and neaten edges.
  - Skip-Troweled Finish with Corner Beads: Even, leveled surface produced by troweling spray-applied finish to smooth out the texture, eliminate surface markings, and square off edges.

415 FIELD QUALITY CONTROL

- Special Inspections: Engage a qualified special inspector to perform the following special inspections:
  - Test and inspect as required by the IBC chapter 17, and ASTM E605.
  - Upon the Engineer’s request, samples of the SFRM shall be randomly selected from approved production batches bearing the applicable classification for independent third-party testing.
  - Testing shall verify compliance with the specified fire-resistance rating and the applicable classification.
  - Any materials found non-compliant shall be removed and replaced at no additional cost to the Employer.
- Perform the tests and inspections of completed Work in successive stages. Do not proceed with application of fire protection for the next area until test results for previously completed applications of fire protection show compliance with requirements. Tested values must equal or exceed values as specified and as indicated and required for approved fire-resistance design.
- Quality Control: Wet and Dry Film Thickness (DFT) shall be checked regularly during applications at intervals as instructed by Engineer.
- Applied fire protection will be considered defective if it does not pass tests and inspections.
  - Remove and replace applied fire protection that does not pass tests and inspections, and retest.
  - Apply additional applied fire protection, in accordance with manufacturer's written instructions, where test results indicate insufficient thickness, and retest.
- Prepare test and inspection reports.

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420 CLEANING

- Immediately after completing spraying operations in each containable area of Project, remove material overspray and fallout from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.

425 PROTECTION

- Protect applied fire protection from damage resulting from construction operations or other causes in accordance with manufacturer's and Installer's written instructions, so applied fire protection is without damage or deterioration at time of Substantial Completion.

430 REPAIRS

- As installation of other adjacent construction proceeds, inspect applied fire protection and repair damaged areas due to work of other trades before concealing it with other construction.
- Repair fire protection damaged by other work before concealing it with other construction.
- Repair applied fire protection using same method and materials as original installation or using manufacturer's recommended trowel-applied repair product.

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M40 STONE/ CONCRETE/ QUARRY/ CERAMIC TILING/ MOSAIC

To be read with Preliminaries/ General Conditions.

TYPES OF TILING/ MOSAIC

110 UNGLAZED FULLY BODY PORCELAIN TILING TO FLOOR AND WHERE INDICATED ON DRAWINGS

- Tiles: stain resistant, acid resistant, slip resistant porcelain complying with BS EN ISO 13006, Group BIa.
  - Manufacturer/ Supplier: Submit proposals.
    Product reference: Submit proposals.
  - Colour: To the Engineer's selection from the manufacturer's standard range.
  - Finish: as indicated in finish manual.
  - Size: as indicated on drawings and finishes manual.
  - Thickness: As per structural verification for floor application and not less than 9.0 mm.
  - Hight for base: 100 mm, color/ finish matching with the adjacent floor finish.
  - Edge: rectified
  - Physical properties (to EN ISO standards)
    - Water absorption: Not more than 0.6% to EN ISO 10545-3.
    - Breaking strength: Not less than 1600 N to EN ISO 10545-4.
    - Flexural strength: Not less than 35 MPa to EN ISO 10545-4.
    - Abrasion resistance:
      - Unglazed tiles: Maximum 150 mm³ to EN ISO 10545-6.
      - Glazed tiles (if used): Class 5 to EN ISO 10545-7.
    - Stain resistance: To EN ISO 10545-14
      - Unglazed tiles: Minimum Class 3.
      - Glazed tiles: Minimum Class 4.
    - Chemical resistance: Class A to EN ISO 10545-13.
  - Slip potential:
    Slip resistance value (SRV) (minimum)/ Pendulum test value (PTV) (minimum) to BS 7976-1, -2, -3 or BS EN 14231 (natural stone only): Manufacturer's standard.
    Surface roughness (Rz) (minimum) to BS 1134: Manufacturer's standard.
    Ramp test class: R11.
  - Recycled content: Contractor's choice.
- Background/ Base: reinforced concrete base.
  - Preparation: acoustic underlay if required in acoustic report.
- Intermediate substrate: Not required.
- Bedding: thin set mortar.
  - Improved modified dry-set cementitious adhesive: Comply with EN 12004-1 / ISO 13007-1, Class C2 E S2.
- Joint width: As spacer lugs.
- Grout: Provide grout type based on location, colour to match tile with cementitious grout in dry areas and epoxy grout in wet, hygienic, and high-traffic areas, unless otherwise indicated on drawings or finishes schedule.
  - Cementitious grout Comply with BS EN ISO 13007-3, ISO 13007-3, and compliant with performance requirements of class CG 2WA (F).
  - Water-Cleanable prepackaged Epoxy grout ISO 13007-3, and compliant to performance requirements of class RG.
- Movement joints: As approved on the contractor's shop drawings.

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- Accessories: None.

110 UNGLAZED FULLY BODY PORCELAIN WALL TILING

- Tiles: stain resistant, acid resistant, slip resistant porcelain complying with BS EN ISO 13006, Group BIa.
  - Manufacturer/ Supplier: Submit proposals.
    Product reference: Submit proposals.
  - Colour: To the Engineer's selection from the manufacturer's standard range.
  - Finish: as indicated in finish manual.
  - Size: as indicated on drawings and finishes manual.
  - Thickness: As indicated in finish manual and drawings.
  - Edge: rectified
  - Physical properties (to EN ISO standards)
    - Water absorption: Not more than 0.6% to EN ISO 10545-3.
    - Breaking strength: Not less than 1600 N to EN ISO 10545-4.
    - Flexural strength: Not less than 35 MPa to EN ISO 10545-4.
    - Stain resistance: To EN ISO 10545-14
      - Unglazed tiles: Minimum Class 3.
      - Glazed tiles: Minimum Class 4.
    - Chemical resistance: Class A to EN ISO 10545-13.
  - Slip potential:
    Slip resistance value (SRV) (minimum)/ Pendulum test value (PTV) (minimum) to BS 7976-1, -2, -3 or BS EN 14231 (natural stone only): Manufacturer's standard.
    Surface roughness (Rz) (minimum) to BS 1134: Manufacturer's standard.
    Ramp test class: R11.
  - Recycled content: Contractor's choice.
- Background/ Base: reinforced concrete base.
  - Preparation: acoustic underlay if required in acoustic report.
- Intermediate substrate: Not required.
- Bedding: thin set mortar.
  - Improved modified dry-set cementitious adhesive: Comply with EN 12004-1 / ISO 13007-1, Class C2 E S2.
  - For wall applications: Provide adhesive complying with non-slip (T) classification in addition to the above requirements.
- Joint width: As spacer lugs.
- Grout: Provide grout type based on location colour to match tile, with cementitious grout in dry areas and epoxy grout in wet, hygienic, and high-traffic areas, unless otherwise indicated on drawings or finishes schedule.
  - Cementitious grout Comply with BS EN ISO 13007-3, ISO 13007-3, and compliant with performance requirements of class CG 2WA (F).
  - Water-Cleanable prepackaged Epoxy grout ISO 13007-3, and compliant to performance requirements of class RG.
- Movement joints: As approved on the contractor's shop drawings.
- Accessories: None.

110A TILING TO WALLS WHERE INDICATED ON DRAWINGS

- Tiles: Glazed ceramic tiles, stain resistant and chemical resistant, complying with BS EN ISO 13006.
  - Interior wet areas: Group BIIa or better
  - Interior dry areas: Group BIIb or better
  - Manufacturer/ Supplier: To the Engineer's selection from the manufacturer's standard range.

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Product reference: To the Engineer's selection from the manufacturer's standard range.
  - Colour and pattern: To the Engineer's selection from the manufacturer's standard range.
  - Finish: as indicated in finish manual.
  - Size: as indicated on drawings and in finish manual.
  - Thickness: As indicated in finish manual and drawings.
  - Recycled content: Contractor's choice.
  - Edge: Rectified.
  - Physical properties (to EN ISO standards):
    - Water absorption: Not more than 6% (wet areas) and 10% (dry areas) to EN ISO 10545-3.
    - Breaking strength: Not less than 1000 N to EN ISO 10545-4.
    - Stain resistance: Minimum Class 4 to EN ISO 10545-14.
    - Chemical resistance: Minimum Class A to EN ISO 10545-13.
- Background/ Base: Cement: sand rendering to section M20.
  - Preparation: as clause 380.
- Intermediate substrate: Not required.
- Bedding: thin set mortar.
  - Improved modified dry-set cementitious adhesive: Comply with EN 12004-1 / ISO 13007-1, Class C2 E S2.
  - For wall applications: Provide adhesive complying with non-slip (T) classification in addition to the above requirements.
- Joint width: As spacer lugs.
- Grout: Provide grout type based on location, with cementitious grout in dry areas and epoxy grout in wet, hygienic, and high-traffic areas, unless otherwise indicated on drawings or finishes schedule .
  - Cementitious grout Comply with BS EN ISO 13007-3, ISO 13007-3, and compliant with performance requirements of class CG 2WA (F).
  - Water-Cleanable prepackaged Epoxy grout ISO 13007-3, and compliant to performance requirements of class RG.
- Movement joints: As approved on the contractor's shop drawings.
- Accessories: As indicated on drawing.

110B CERAMIC SKIRTING WHERE INDICATED ON DRAWINGS

- Tiles: Glazed ceramic tiles, stain resistant and chemical resistant, complying with BS EN ISO 13006.
  - Interior wet areas: Group BIIa or better
  - Interior dry areas: Group BIIb or better
  - Manufacturer/ Supplier: To the Engineer's selection from the manufacturer's standard range.
    Product reference: To the Engineer's selection from the manufacturer's standard range.
  - Colour and pattern: To the Engineer's selection from the manufacturer's standard range.
  - Finish: as indicated in finish manual.
  - Size: as indicated on drawings and in finish manual.
  - Height: 200mm, unless otherwise indicated.
  - Thickness: As indicated in finish manual and drawings.
  - Recycled content: Contractor's choice.
  - Edge: Rectified.
  - Physical properties (to EN ISO standards):
    - Water absorption: Not more than 6% (wet areas) and 10% (dry areas) to EN ISO 10545-3.
    - Breaking strength: Not less than 1000 N to EN ISO 10545-4.
    - Stain resistance: Minimum Class 4 to EN ISO 10545-14.
    - Chemical resistance: Minimum Class A to EN ISO 10545-13.

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- Background/ Base: Cement: sand rendering to section M20.
  - Preparation: as clause 380.
- Intermediate substrate: Not required.
- Bedding: thin set mortar.
  - Improved modified dry-set cementitious adhesive: Comply with EN 12004-1 / ISO 13007-1, Class C2 E S2.
  - For wall applications: Provide adhesive complying with non-slip (T) classification in addition to the above requirements.
- Joint width: As spacer lugs.
- Grout: Provide grout type based on location, with cementitious grout in dry areas and epoxy grout in wet, hygienic, and high-traffic areas, unless otherwise indicated on drawings or finishes schedule .
  - Cementitious grout Comply with BS EN ISO 13007-3, ISO 13007-3, and compliant with performance requirements of class CG 2WA (F).
  - Water-Cleanable prepackaged Epoxy grout ISO 13007-3, and compliant to performance requirements of class RG.
- Movement joints: As approved on the contractor's shop drawings.
- Accessories: As indicated on drawing.

115 MARBLE STONE FOR FLOORING AND WALL CLADDING WHERE INDICATED ON DRAWINGS

- Marble tiles/ slabs: Natural marble, sound, durable, free from cracks, vents, or other structural defects.
  - Manufacturer/ Supplier: Submit proposals.
    Product reference: Submit proposals.
  - Colour/ Veining/ Texture: As indicated on drawings and finishes manual, consistent across batch.
  - Finish: As indicated on drawings and finishes manual.
  - Size/ Format: As indicated on drawings and finishes manual.
  - Thickness: As per structural verification for floor application and not less than 20 mm.
  - Edge: Machine-cut, straight and true, arris slightly eased.
  - Slip resistance: Minimum R10.
  - Surface roughness (Rz) to BS 1134: Manufacturer’s standard.
- Comply with BS EN 12057 / BS EN 12058 and the following:
  - Water absorption: Max. 0.2% (BS EN 13755).
  - Density: Min. 2650 kg/m³ (BS EN 1936).
  - Compressive strength: Min. 55 MPa (BS EN 1926).
  - Flexural strength: Min. 7 MPa (BS EN 12372).
  - Abrasion resistance: As per BS EN 14157, suitable for heavy traffic.
  - Flexural strength (wet/dry): Min. 7 MPa (BS EN 12372 / 13161).
- Background/ Base: Reinforced concrete base or masonry wall, prepared and level.
- Bedding:
  - Flooring: Thick-bed cement: sand mortar or approved adhesive. or improved modified dry-set cementitious adhesive: Comply with EN 12004-1 / ISO 13007-1, Class C2 E S2
  - For wall applications: Provide adhesive complying with non-slip (T) classification in addition to the above requirements.
- Grout: Provide grout type based on location colour to match tile, with cementitious grout in dry areas and epoxy grout in wet, hygienic, and high-traffic areas, unless otherwise indicated on drawings or finishes schedule.
  - Cementitious grout Comply with BS EN ISO 13007-3, ISO 13007-3, and compliant with performance requirements of class CG 2WA (F).

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  - Water-Cleanable prepackaged Epoxy grout ISO 13007-3, and compliant to performance requirements of class RG.
- Movement joints: Proprietary profiles or sealant joints as approved, located in accordance with BS 5385-1 (floors) and BS 5385-2 (walls).
- Sealing/ Protection:
  - Apply breathable impregnating sealer suitable for marble.
  - Protect installed marble from staining, scratching, and impact damage until Practical Completion.

115 A LIMESTONE FOR FLOORING AND WALL CLADDING WHERE INDICATED ON DRAWINGS

- Limestone tiles/slabs**:** Natural limestone, sound, durable, free from cracks, voids, or structural defects.
  - Manufacturer/ Supplier: Submit proposals.
    Product reference: Submit proposals.
  - Colour/ Veining/ Texture: As indicated on drawings and finishes manual, consistent across batch.
  - Finish: As indicated on drawings and finishes manual.
  - Size/ Format: As indicated on drawings and finishes manual.
  - Thickness: As per structural verification for floor application and not less than 20 mm.
  - Edge: Machine-cut, straight and true, arris slightly eased.
  - Slip resistance: Minimum R10.
  - Surface roughness (Rz) to BS 1134: Manufacturer's standard.
- Comply with BS EN 12057 / BS EN 12058 and the following:
  - Water absorption: Maximum 4%, tested to BS EN 13755.
  - Density: Minimum 2200 kg/m³, tested to BS EN 1936.
  - Compressive strength: Minimum 30 MPa, tested to BS EN 1926.
  - Flexural strength: Minimum 6 MPa, tested to BS EN 12372.
  - Abrasion resistance (for flooring): Tested to BS EN 14157; suitable for foot traffic.
- Background/ Base: Reinforced concrete base or masonry wall, prepared and level.
- Bedding:
  - Flooring: Thick-bed cement: sand mortar or approved adhesive. or improved modified dry-set cementitious adhesive: Comply with EN 12004-1 / ISO 13007-1, Class C2 E S2
  - For wall applications: Provide adhesive complying with non-slip (T) classification in addition to the above requirements.
- Grout: Provide grout type based on location colour to match tile, with cementitious grout in dry areas and epoxy grout in wet, hygienic, and high-traffic areas, unless otherwise indicated on drawings or finishes schedule.
  - Cementitious grout Comply with BS EN ISO 13007-3, ISO 13007-3, and compliant with performance requirements of class CG 2WA (F).
  - Water-Cleanable prepackaged Epoxy grout ISO 13007-3, and compliant to performance requirements of class RG.
- Movement joints: Proprietary profiles or sealant joints as approved, located in accordance with BS 5385-1 (floors) and BS 5385-2 (walls).
- Sealing/ Protection:
  - Apply breathable impregnating sealer suitable for marble.
  - Protect installed marble from staining, scratching, and impact damage until Practical Completion.

115B NATURAL STONE COVERING TO THRESHOLD

- Type: Slabs to BS EN 12058.
- Stone:

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  - Name (traditional): marble.
  - Petrological family: Marble.
  - Colour: White, unless otherwise indicated on drawings and in finish manual.
  - Origin: as indicated in the finish's manual.
  - Finish: Polished unless otherwise indicated in the finish's manual.
  - Supplier: Submit proposals.
  - Quality: Free from vents, cracks, fissures, discoloration, or other defects deleterious to strength/ colour.
  - Size: as indicated in the finish's manual.
  - Thickness: as indicated in the finish's manual.
  - Slip potential:
    Slip resistance value (SRV) (minimum) to BS EN 14231: 35 wet.
    Surface roughness (Rz) (minimum) to BS 1134: Manufacturer's standard.
    Ramp test class: R11.
  - Other requirements: None.
- Background/ Base: Cement: sand rendering as section M20.
  - Preparation: Smoothing underlayment.

GENERAL

210 SUITABILITY OF BACKGROUNDS/ BASES

- Background/ base tolerances: To permit specified flatness/ regularity of finished surfaces given the permissible minimum and maximum thickness of bedding.
- New background drying times (minimum):
  - Concrete walls: 6 weeks.
  - Brick/ block walls: 6 weeks.
  - Rendering: 2 weeks.
  - Gypsum plaster: 4 weeks.
- New base drying times (minimum):
  - Concrete slabs: 6 weeks.
  - Cement: sand screeds: 3 weeks.

215 FALLS IN THE BASES

- General: Give notice if falls are inadequate.

250 SAMPLES

- General: Submit representative samples of the following:
  Each type of tile.

260 CONTROL SAMPLES

- General: Complete sample areas, being part of finished work, in locations as follows: As agreed with the Engineer.
  - Approval of appearance: Obtain before proceeding.
- Floor covering slip resistance testing: As clause 900.

PREPARATION

370 NEW IN SITU CONCRETE

- Backgrounds/ bases to be tiled: Remove mould oil, surface retarders and other materials incompatible with bedding.

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380 NEW PLASTER

- Plaster: Dry, solidly bedded, free from dust and friable matter.
- Plaster primer: Apply if recommended by adhesive manufacturer.

400 BACKGROUNDS as indicated

- Boards: Dry, securely fixed and rigid with no protruding fixings.
- Surfaces to be tiled: Seal or prime if recommended by adhesive manufacturer.

410 HACKING FOR KEY

- Keying: Roughen backgrounds thoroughly and evenly to a depth of 3 mm.
- Backgrounds to be keyed: as indicated.

420 RAKING OUT FOR KEY

- Soft joints in existing masonry: Rake out to a depth of 13 mm (minimum).

430 SPATTERDASHING FOR KEY

- Spatterdash mix:
  - Cement: Portland to BS EN 197-1 type CEM I/42.5
  - Sand: Clean coarse.
  - Proportions (cement: sand): 1-1.5:2.
  - Admixture: BBA certified SBR bonding agent.
  - Consistency: Thick slurry with no segregation.
- Application/finish: Thrown.
  - Thickness: 3-5 mm.
- Curing/ drying: Keep damp until hardened. Dry out to provide securely bonded finish.

438 PREPARING CONCRETE BASES FOR FULLY BONDED BEDDING

- Surface cement: sand matrix: Remove to expose coarse aggregate.
- Surface preparation: Suitable to achieve a full bond with bedding. Select from:
  - Keep well wetted for several hours. Remove free water then brush in a slurry bonding coat.
    Slurry: SBR polymer modified cement.
  - Prepare, prime as necessary and apply a bonding agent.
    Bonding agent: BBA certified SBR bonding agent.

451 PREPARING CONCRETE BASES FOR UNBONDED BEDDING

- Separating layer: Polyethylene sheet.
  - Thickness: 125 micrometres (500 gauge).
  - Lap at joints: 100 mm.

460 SMOOTHING UNDERLAYMENT

- Type: Recommended by adhesive manufacturer.
- Condition: Allow to dry before tiling.

470 INTERMEDIATE SUBSTRATE

- Type: Tile backer board, where indicated on drawings.
  - Manufacturer: Submit proposals.
    Product reference: Submit proposals.
  - Thickness: 12.5 mm, unless otherwise indicated on drawings.
- Fixing system: Bonding mortar.
  - Manufacturer: Submit proposals.
    Product reference: Submit proposals.
  - Application: As recommended by manufacturer.

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  - Substrate surface: Secure, true and even.
- Joints: Close butt.
  - Treatment: As recommended by manufacturer.
- Penetrations: Seal.
- Accessories: None.

FIXING

510 FIXING GENERALLY

- Colour/ shade: Unintended variations within tiles for use in each area/ room are not permitted.
  - Variegated tiles: Mix thoroughly.
- Adhesive: Compatible with background/ base. Prime if recommended by adhesive manufacturer.
- Use of admixtures with cementitious adhesives: Only admixtures approved by adhesive manufacturer.
- Cut tiles: Neat and accurate.
- Fixing: Provide adhesion over entire background/ base and tile backs.
- Final appearance: Before bedding material sets, make adjustments necessary to give true, regular appearance to tiles and joints when viewed under final lighting conditions.
- Surplus bedding material: Clean from joints and face of tiles without disturbing tiles.

540 LEVEL OF FLOOR TILING

- Permissible deviation in level from datum 3 mm.

550 FLATNESS/ REGULARITY OF TILING/ MOSAICS

- Sudden irregularities: Not permitted.
- Deviation of surface: Measure from underside of a 2 m straightedge with 3 mm thick feet placed anywhere on surface. The straightedge should not be obstructed by the tiles and no gap should be greater than 6 mm, i.e. a tolerance of + 3 mm.

560 LEVEL OF TILING ACROSS JOINTS

- Deviation (maximum) between tile surfaces either side of any type of joint:
  - 1 mm for joints less than 6 mm wide.
  - 2 mm for joints 6 mm or greater in width.

570 MORTAR BEDDING

- Bedding mix:
  - Cement: Portland to BS EN 197-1, type CEM I/42.5.
  - Sand for walls: Fine aggregate to BS EN 13139.
    Grading designation: 0/2 (CP or MP) category 2 fines.
  - Sand for floors: Fine aggregate to BS EN 13139.
    Grading designation: 0/4 (MP) category 1 fines and between 20%-66% passing a 0.5 sieve.
- Batching: Select from:
  - Batch by weight.
  - Batch by volume: Permitted on the basis of previously established weight: volume relationships of the particular materials. Use accurate gauge boxes. Allow for bulking of damp sand.
- Mixing: Mix materials thoroughly to uniform consistence. Use a suitable forced action mechanical mixer. Do not use a free fall type mixer.
- Application: At normal temperatures use within two hours. Do not use after initial set. Do not retemper.

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578 CRACK CONTROL REINFORCEMENT

- Type to BS 4483: D98.
- Installation: Place centrally in depth of bed. Lap not less than 100 mm and securely tie together with steel wire.
- Corners: Avoid a four-layer build at corners.

590 COVED TILE SKIRTINGS

- Sequence: Bed solid to wall before laying floor tiles.
- Bedding: 1:4 cement: sand mortar.

600 SIT-ON TILE SKIRTINGS

- Sequence: Bed solid to wall after laying floor tiles.
- Bedding: 1:4 cement: sand mortar.

650 ADHESIVE BED - NOTCHED TROWEL METHOD (WALLS)

- Application: By 3 mm floated coat of adhesive to dry background in areas of approximately 1 m². Comb surface.
- Tiling: Press tiles firmly onto float coat.

651 ADHESIVE BED - NOTCHED TROWEL AND BUTTERING METHOD (WALLS)

- Application: By floated coat of adhesive to dry background in areas of about 1 m². Comb surface.
- Tiling: Apply thin even coat of adhesive to backs of dry tiles. Fill any ribbed, deep keyed or button profiles. Press tiles firmly onto float coat.
- Finished adhesive thickness: 3 mm or within the range allowed by the adhesive manufacturer.

652 ADHESIVE BED - BUTTERING METHOD (WALLS)

- Tiling: Apply even coat of adhesive to backs of dry tiles. Fill any ribbed, deep keyed or button profiles.
- Finished adhesive thickness: 3 mm or within the range allowed by the adhesive manufacturer.

690 CEMENT: SAND MORTAR BEDDING (WALLS)

- Preparation: Dampen background.
- Application: By floated coat to background: 1:3-4 cement: sand mortar bedding.
  - Thickness (maximum): 10 mm.
  - Finish: Equivalent to wood float. Before tiling allow to stiffen slightly.
- Tiling: Without delay, apply 2 mm thick coat of 1:1 cement: fine sand mortar to backs of tiles, filling keys. Press tiles firmly onto float coat. Tap firmly into position

710 ADHESIVE BED - NOTCHED TROWEL AND BUTTERING METHOD (FLOORS)

- Application: Floated coat of adhesive to dry base and comb surface.
- Tiling: Apply coat of adhesive to backs of dry tiles. Fill any ribbed, deep keyed or button profiles. Press tiles firmly onto float coat.
- Finished adhesive thickness: Within range allowed by manufacturer.

711 ADHESIVE BED - BUTTERING METHOD (FLOORS)

- Tiling: Apply even coat of adhesive to backs of dry tiles. Fill any ribbed, deep keyed or button profiles.
- Finished adhesive thickness: Within the range allowed by the adhesive manufacturer.

720 CEMENT: SAND MORTAR BEDDING (FLOORS)

- Mortar bedding mix: 1:3-4 cement: sand.
  - Consistency: Stiff plastic.

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- Laying: Lay suitably small working areas of screeded bed. Compact thoroughly to level.
  - Finished bed thickness:
    For tiles up to 10 mm thick: 10-15 mm.
    For tiles greater than 10 mm thick: 15-20 mm.
- Tiling: Within two hours and before bedding sets, evenly coat backs of tiles with adhesive. Press tiles firmly into position.
- Finished adhesive thickness: Within range recommended by manufacturer.

740 EDGINGS AND COVER STRIPS

Manufacturer: Submit proposals.
Product reference: Submit proposals.
Material/ finish: Stainless steel Grade 316, as recommended by manufacturer.
Fixing: Secure with edge of covering gripped. Use matching fasteners where exposed to view

MOVEMENT JOINTS/ GROUTING/ COMPLETION

805 SEALANT MOVEMENT JOINTS WITH METAL EDGINGS WHERE INDICATED

- Edging material: Stainless steel angle.
  - Size: as indicated.
  - Bedding: Bed in 1:3 cement: sand.
- Installation: Centre over joints in base. Set to exact finished level of floor.
  - Fixing to base: Stainless steel screws and plugs at 300mm centres.
- Joint width: To match that of structural movement joint in base.
- Sealant: Multi-component, chemically curing, high performance polyurethane trafficable joint sealant.
  - Colour: To the Engineer's selection from the manufacturer's standard range.
  - Preparation and application: As section Z22.

815 SEALANT MOVEMENT JOINTS WHERE INDICATED

- Joints: Extend through tiles and bedding to base/ background. Centre over joints in base/ background.
  - Width: 6 mm.
- Sealant: Multi-component, chemically curing, high performance polyurethane trafficable joint sealant.
  - Colour: To the Engineer's selection from the manufacturer's standard range.
  - Preparation and application: As section Z22.

835A METAL SECTION MOVEMENT JOINTS IN TILING TO FLOORS

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
  - Colour: as selected by Engineer from manufacturer's full range.
- Bedding: Bed in 1:3 cement: sand.
- Installation: Centre over joints in base. Set to exact finished level of floor.
- Fixing to base: stainless steel screws, washers and plugs at 300 mm centres, unless otherwise indicated.
- Material: aluminium that shall be made of high-performance industrial grade, and to be developed for commercial applications, with two anchoring legs, polyurethane infill and a visible width of 11 mm. Joints shall provide effective lateral movement control in the specified traffic conditions. Joint infill shall offer high resistance to most commonly used chemicals and mechanical stresses.
  Movement: +/- 30%.
- Point load: 250 kg (25 mm diameter surface).

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875 GROUTING

- Sequence: Grout when bed/adhesive has set sufficient to prevent disturbance of tiles.
- Joints: 6 mm deep (or depth of tile if less). Free from dust and debris.
- Grouting: Fill joints completely, tool to profile, clean off surface. Leave free from blemishes.
  - Profile: Slightly concave.
- Polishing: When grout is hard, polish tiling with a dry cloth.

885 COLOURED GROUTS

- Staining of tiles: Not permitted
- Evaluating risk of staining: Apply grout to a few tiles in a small trial area. If discoloration occurs apply a protective sealer to tiles and repeat trial.

PERFORMANCE

910 PENDULUM FLOOR COVERING SLIP RESISTANCE TESTING

- Natural stone floor covering(s) to be tested: M40/ porcelain and ceramic tiles.
- Testing authority: An approved laboratory.
- Test: To BS EN 14231.
  - Floor covering condition: Dry and wet.
  - Witnessing/ Certification: Arrange for tests to be witnessed/ certified by: Contract Administrator.
  - Report: Submit in addition to the requirements of the standard include:
    Location of the site and a drawing showing the positions of the tests.
    Description of the surface tested and its condition.
    Slider material used.
    PTV at each position tested.
    Temperature of the test surface.

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M50 RUBBER/ PLASTICS/ CORK/ LINO/ CARPET TILING/ SHEETING

To be read with Preliminaries/ General Conditions.

TYPES OF COVERING

110B TILING STATIC CONDUCTIVE PLASTICS

- Location: as indicated.
- Base: smooth Trowelled screed.
  - Preparation: substrate to be smooth trowelled finish, free from debris and dust.
- Fabricated underlay: as indicated.
- Tiles: Homogeneous PVC to BS EN ISO 10581.
- PVC to be of high performance electrostatic and conductive floor covering. Static conductive flooring to be designed for full and unconditional ESD/ EMI control as well as for contamination sensitive clean room applications.
- Electrical resistance range: 5 x 10^4–1 x 10^6 ohm.
- Abrasion resistance (to BS EN 660-1): 0.15 mm.
- Static electrical propensity: to BS EN 1815: <2 kV.
  - Manufacturer: Submit proposals.
    Product reference: Not applicable.
  - BS EN ISO 10874 class: 43.
  - Slip potential:
    Slip resistance value (SRV) (minimum)/ Pendulum test value (PTV) (minimum) to BS 7976-1, -2 and -3: 36/ 25 dry/ wet.
    Surface roughness (Rz) (minimum) to BS 1134: 30 micrometres.
  - Recycled content: 25% (minimum to BS EN ISO 14021.
  - Size: 600 mm, unless otherwise indicated.
  - Thickness: not less than 2 mm.
  - Colour/ pattern: To the Engineer's selection from the manufacturer's standard range.
- Adhesive (and primer if recommended by manufacturer): As clause 640.
- Accessories: PVC skirtings.
- Finishing: Wash and test electrical resistance.
- Other requirements: A static conductive copper earth strip to be used in conjunction with static conductive primer and adhesive.
- Where high hygiene requirements are indicated on drawings, use a coved skirting system, as per manufacturer's recommendations.
- Pre-formed corners and skirting strips should be fitted after the main field tiles have been installed
- All joints to be hot welded in accordance with the manufacturer’s instructions.

120A HETEROGENEOUS VINYL SHEET

- Location: as indicated.
- Base: smooth Trowelled screed.
  - Preparation: substrate to be smooth trowelled finish, free from debris and dust.
- Fabricated underlay: as indicated.
- Tiles: Heterogeneous vinyl to BS EN ISO 10582.
  - Manufacturer: Submit proposals.
    Product reference: Not applicable.
  - BS EN ISO 10874 class: 43.
  - Slip potential:

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Slip resistance value Minimum R10 to DIN 51130 (SRV) (minimum)/ Pendulum test value (PTV) (minimum) to BS 7976-1, -2 and -3: 36/ 25 dry/ wet.
Surface roughness (Rz) (minimum) to BS 1134: 30 micrometres.

- Recycled content: 25% (minimum to BS EN ISO 14021.
- Size: To the Engineer's selection from the manufacturer's standard range.
- Thickness: not less than 3 mm.
- Colour/ pattern: To the Engineer's selection from the manufacturer's standard range.

- Adhesive (and primer if recommended by manufacturer): as specified below.
- Accessories: PVC skirtings where indicated.
- Finishing: Welded joints, clean and finish to manufacturer's recommendations.
- Other requirements: None.

120B HOMOGENEOUS VINYL SHEET

- Location: as indicated.
- Base: smooth Trowelled screed.
  - Preparation: substrate to be smooth trowelled finish, free from debris and dust.
- Tiles: Heterogeneous vinyl to BS EN ISO 10582.
  - Manufacturer: Submit proposals.
    Product reference: Not applicable.
  - BS EN ISO 10874 class: 43.
  - Slip potential:
    Slip resistance value Minimum R19 to DIN 51130 (SRV) (minimum)/ Pendulum test value (PTV) (minimum) to BS 7976-1, -2 and -3: 36/ 25 dry/ wet.
    Surface roughness (Rz) (minimum) to BS 1134: 30 micrometres.
  - Recycled content: 25% (minimum to BS EN ISO 14021.
  - Size: To the Engineer's selection from the manufacturer's standard range.
  - Anti-bacterial: Required for medical areas
  - Thickness: not less than 2 mm.
  - Colour/ pattern: To the Engineer's selection from the manufacturer's standard range.
- Adhesive (and primer if recommended by manufacturer): as specified below.
- Accessories: PVC skirtings, where indicated.
- Finishing: Welded joints, clean and finish to manufacturer's recommendations.
- Other requirements: None.

130A CARPET TILING

- Location: where indicated on drawings.
- Base: Power floated concrete.
  - Preparation: As clause 460.
- Fabricated underlay: Not required unless recommended by manufacturer.
- Carpet tiles:
  - Manufacturer: Submit proposals.
    Product reference: Not applicable.
  - Type: Tufted structured loop pile, unless otherwise indicated in finishes manual.
  - Fibre: 100% solution dyed nylon with recycled content.
  - Backing: Manufacturer's standard backing system.
  - BS EN 1307 classification:
    Levels of use class: 33.
    Luxury rating class: LC5.
    Additional performance properties to BS EN 1307:
  - Castor chair suitability (Intensive use);

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  - Castor chair suitability (Occasional use).
  - Antistatic behaviour.
  - Acoustic properties (Impact sound insulation, absorption).
  - Suitability occasional humid conditions (Dimensional stability).
  - Suitability occasional humid conditions (Colour fastness to wet/ dry rubbing).
  - Suitability occasional humid conditions (Resistance to rot).
  - Suitability for use on stairs (Intensive use).
  - Suitability for use on stairs (Occasional use); and
- Resistant to fraying.
  - Recycled content: Contractor's choice.
  - Size: as indicated in the finish's manual.
  - Colour/ pattern: To the Engineer's selection from the manufacturer's standard range.
- Pile height: As indicated in finishes manual.
- Total thickness: As indicated in finishes manual.
- Total weight: To the Engineer's selection from the manufacturer's standard range.
- Method of laying: Fully adhere all tiles with release adhesive recommended by tile manufacturer.
- Accessories: Edging strip at thresholds as clause 740.
- Other requirements: None.

170 CARPETING

- Location: where indicated.
- Base: Power floated concrete.
  - Preparation: Make good concrete.
- Fabricated underlay: none.
- Carpet underlay to BS 5808 and BS EN 14499:
  - Manufacturer: Submit proposals.
    Product reference: Not applicable.
  - Type: Cellular rubber.
  - Class: HC/U.
  - Recycled content: Contractor's choice.
- Underlay adhesive (and primer if recommended by manufacturer): as recommended by manufacturer.
- Carpet:
  - Manufacturer: submit proposals.
    Product reference: submit proposals.
  - Type: loop pile.
  - BS EN 1307 classification:
    Levels of use class: 33.
    Luxury rating class: LC3.
    Additional performance properties to BS EN 1307:
  - Castor chair suitability (Intensive use).
  - Electrical propensity (Static dissipative floor covering).
  - Acoustic properties (Impact sound insulation).
  - Acoustic properties (Sound absorption).
  - Suitability occasional humid conditions (Resistance to rot).
  - Suitability for use on stairs (Intensive use); and
- Resistant to fraying.
  - Recycled content: Contractor's choice.
  - Width: as indicated.

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- Colour/ pattern: submit proposals.
- Carpet adhesive (and primer if recommended by manufacturer): recommended by manufacturer.
- Accessories: as recommended by manufacturer.
- Other requirements: None.

180 RESIN QUARTZ FLOOR TILES AND WHERE INDICATED

- Location: As indicated on drawings and finishes schedule.
- Substrate: Cementitious screed or concrete, clean, dry, level, and prepared in accordance with manufacturer's recommendations.
- Flooring:
  - Type: Resin quartz floor tiles (epoxy or polyurethane bound quartz aggregate as manufacturers standards) to BS 8204-6, with aggregates to BS EN 12620.
  - Size: As indicated in finish manuals and drawing.
  - Thickness: As per structural verification for floor application and not less than 9.0 mm.
  - Colour: Greige, or as selected by Engineer from manufacturer's standard range.
  - Finish: Honed / smooth matt, slip resistant.
- Performance:
  - Slip resistance: Slip resistance value (SRV) (minimum)/ Pendulum test value (PTV) (minimum) to BS 7976-1, -2, -3.
  - Surface roughness (Rz) (minimum) to BS 1134: Manufacturer's standard.
  - Ramp test class: R11.
- Fire classification: Minimum Bfl-s1 to EN 13501-1.
- Bond strength: Minimum 1.5 MPa adhesion to substrate.
- Installation:
  - Adhesive: Resin-based adhesive as recommended by manufacturer.
  - Joints: Close-jointed or resin-filled.
  - Movement joints: To align with substrate joints and as per BS 8204.
- Accessories: Edge trims, skirtings, and coves where indicated.
- Finishing: To the Engineer's selection from the manufacturer's standard range.

190 TERRAZZO TILE FLOORING

- Substrate: Cementitious screed to BS 8204.
- Preparation: Mechanically clean, dry, level and prepared to ensure adhesion.
- Terrazzo tiles:
  - Type: Factory-produced terrazzo tiles complying with BS EN 13748-1 (cementitious) or BS EN 13748-2 (resin-based).
    - Manufacturer: Submit proposals to Engineer's approval.
    - Product reference: As approved.
  - Binder: Cementitious or resin based as specified.
  - Aggregates: Natural marble, granite, or recycled glass.
  - Size: As indicated on drawings / finishes manual.
  - Thickness: As per structural verification for floor application and not less than 20 mm (cementitious) or 15 mm (resin-based).
  - Colour: As indicated in finishes manual.
  - Finish: To the Engineer's selection from the manufacturer's standard range.
- Bedding: Cementitious adhesive to EN 12004, Class C2.
- Jointing:
  - Joint width: 2–5 mm unless otherwise indicated.
  - Grout: Cementitious grout to BS EN ISO 13007-3, Class CG2 WA, or epoxy grout in wet areas.
- Divider strips: Stainless steel strip Grade 316, at movement joints or where indicated.

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- Slip resistance: Minimum R11, unless othewise indicated.
- Durability:
  - Suitable for heavy-duty traffic including trolleys.
  - Abrasion resistance: To BS EN 13748.
  - Resistant to staining and cleaning chemicals.
- Water / Vapour resistance:
  - Tiles to be sealed and joints properly grouted.
- Other requirements:
  - Uniform colour and aggregate distribution.
  - Accurate alignment and consistent jointing.

200 RUBBER FLOORING WHERE INDICATED

- Location: As indicated on drawings and finishes schedule.
- Substrate: Cementitious screed or concrete to BS 8204.
  - Preparation: Mechanically clean, dry, level, and prepared to ensure adhesion.
- Flooring:
  - Type: Rubber sheet or tile flooring complying with BS EN 1817.
  - Manufacturer: Submit proposals to Engineer's approval.
    Product reference: As approved.
- Classification: Heavy-duty commercial use to BS EN ISO 10874, Class 34/43.
- Thickness: As indicated in finish manuals, but not less than 3.5mm.
- Finish: As indicated in finish manuals.
- Colour: As selected by the Engineer from manufacturer's standard range.
- Recycled content: Manufacturer's standard.
- Performance:
  - Slip resistance: Minimum R10 to DIN 51130 unless otherwise indicated.
  - Fire classification: Minimum Bfl-s1 to EN 13501-1.
  - Indentation resistance: To BS EN ISO 24343-1.
  - Abrasion resistance: To BS EN ISO 4649.
  - Acoustic performance: As indicated in acoustic report.
- Installation:
  - Adhesive: As recommended by manufacturer.
  - Joints: Close-butt joints, heat welded where required.
  - Movement joints: To align with substrate joints.
- Finishing: As selected by the Engineer from manufacturer's standard range
- Other requirements:
  - Low VOC emissions.
- Anti-bacterial properties where required.

GENERAL REQUIREMENTS

210 WORKMANSHIP GENERALLY

- Base condition after preparation: Rigid, dry, sound, smooth and free from grease, dirt and other contaminants.
- Finished coverings: Accurately fitted, tightly jointed, securely bonded, smooth and free from air bubbles, rippling, adhesive marks and stains.

220 SAMPLES

- Covering samples: Before placing orders, submit representative sample of each type.

230 CONTROL SAMPLES

- General: Complete areas of finished work in approved locations as follows and obtain approval of appearance before proceeding where indicated.

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250 LAYOUT - ROLL MATERIALS

- Setting out of seams: Agree setting out for sheeting types M50/ where specified.

251 LAYOUT - SEAMS IN ROLL MATERIALS

- Setting out: Minimise occurrences of seams and cross seams.
- Cross seams: Not permitted in following locations: as indicated on drawings.

330 COMMENCEMENT

- Required condition of works prior to laying materials:
  - Building is weathertight and well dried out.
  - Wet trades have finished work.
  - Paintwork is finished and dry.
  - Conflicting overhead work is complete.
  - Floor service outlets, duct covers and other fixtures around which materials are to be cut are fixed.
- Notification: Submit not less than 48 hours before commencing laying.

340 CONDITIONING

- Prior to laying: Condition materials by unpacking and separating in spaces where they are to be laid. Maintain resilient flooring rolls in an upright position. Unroll carpet and keep flat on a supporting surface.
- Conditioning time and temperature (minimum): As recommended by manufacturer with time extended by a factor of two for materials stored or transported at a temperature of less than 10°C immediately prior to laying.

350 ENVIRONMENT

- Temperature and humidity: Before, during and after laying, maintain approximately at levels which will prevail after building is occupied.
- Ventilation: Before during and after laying, maintain adequate provision.

PREPARING BASES

410 NEW BASES

- Suitability of bases and conditions within any area: Commencement of laying of coverings will be taken as acceptance of suitability.

440 SUBSTRATES TO RECEIVE THIN COVERINGS

- Trowelled finishes: Uniform, smooth surface free from trowel marks and other blemishes. Abrade suitably to receive specified floor covering material.

460 SMOOTHING/ LEVELLING UNDERLAYMENT COMPOUND

- Type: As recommended by covering manufacturer.
- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.

470 BASES FROM WHICH EXISTING FLOOR COVERINGS HAVE BEEN REMOVED

- Substrate: Clear of covering and as much adhesive as possible. Skim with smoothing underlayment compound to give smooth, even surface.

LAYING COVERINGS

610 SETTING OUT TILES

- Method: Set out from centre of area/ room, so that wherever possible:

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- Tiles along opposite edges are of equal size.
- Edge tiles are more than 50% of full tile width.

620 COLOUR CONSISTENCY

- Finished work in any one area/ room: Free from banding or patchiness.

640A ADHESIVE FIXING GENERALLY

- Adhesive type: As specified, as recommended by covering/ underlay, manufacturer or as approved.
- For conductive flooring, adhesive to be: A conductive polyurethane resin and hardener, water-resistant, low VOC-emission (EC1) two-component PU-adhesive.
- Primer: Type and usage as recommended by adhesive manufacturer.
- Application: As necessary to achieve good bond.
- Finished surface: Free from trowel ridges, high spots caused by particles on the substrate, and other irregularities.

650 SEAMS

- Patterns: Matched.
- Joints: Tight without gaps.

670 BORDERS/ AND FEATURE STRIPS IN SHEET MATERIAL

- Curl: Not acceptable.
- Corners: Mitre joints.

680 SEAM WELDING COVERINGS

- Commencement: At least 24 hours after laying, or after adhesive has set.
- Joints: Neat, smooth, strongly bonded, flush with finished surface.

720 DOORWAYS

- Joint location: On centre line of door leaf.

740 EDGINGS AND COVER STRIPS

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Material/ finish: Stainless steel Grade 316, as recommended by manufacturer.
- Fixing: Secure with edge of covering gripped. Use matching fasteners where exposed to view

750 STAIR NOSINGS AND TRIMS

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Material/ finish: as indicated on drawings and in finishes manual.
- Fixing: Secure, level and with mitred joints. Adjusted to suit thickness of covering with continuous packing strips of hardboard or plywood. Nosing's and packing strips bedded in gap-filling adhesive recommended by nosing manufacturer.
  - Screw fixing with matching plugs: Not required.

770 SKIRTINGS

- Types: PVC.
- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Fixing: Secure with top edge straight and parallel with floor.
  - Corners: Mitre joints.

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780 TRAFFICKING AFTER LAYING

- Covering types: as indicated.
- Traffic free period: Until adhesive is set.

COMPLETION

820 FINISHING PLASTICS FLOORING

- Cleaning operations:
  - Wash floor with water containing neutral (pH 6-9) detergent. If necessary, lightly scrub heavily soiled areas.
  - Rinse with clean water, removing surplus to prevent damage to adhesive. Allow to dry.
- Emulsion polish: Two coats of a type recommended by covering manufacturer.

825 FINISHING NON-TEXTILE ANTISTATIC FLOORING

- Cleaning operations:
  - Wash floor with water containing neutral (pH 6-9) detergent. If necessary, lightly scrub heavily soiled areas.
  - Rinse with clean water, removing surplus to prevent damage to adhesive. Allow to dry for not less than 24 hours before testing.

860 TESTING ANTISTATIC FLOORING

- Floor covering to be tested: M50/ General antistatic 5 x 104 min, and 1 x 108 max.
- Test methods: In accordance with BS 2050, clause A.4.1.
- Required electrical resistance values:
  - Upper limit:
    Average value not more than 1 x 108 ohms.
    No individual reading more than 1 x 108 ohms.
  - Lower limit:
    Average value not less than 5 x 104 ohms.
    No individual reading less than 5 x 104 ohms.
- Electrical resistivity: Submit and agree date and time of test. Record and submit results.
- Floor covering details sign: Before fixing, agree location and submit details of a brass plate, size 50 x 75 mm, engraved with the following details:
  The words 'ANTISTATIC FLOOR'.
  Manufacturer and reference of flooring.
  Name of flooring contractor.
  Date when laid.

861 SLIP RESISTANCE TESTING

- Testing authority: A UKAS accredited laboratory or an approved laboratory.
- Floor covering(s) to be tested: dry and wet.
- Test: To BS 7976-1, -2 and -3.
  - Floor covering condition: Dry and wet.
  - Witnessing/ Certification: Arrange for tests to be witnessed/ certified by: third party testing agency.
- Report: Submit.

880 WASTE

- Spare covering material: Retain suitable material for patching. On completion submit pieces for selection. Hand over selected pieces to Employer.

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M60 PAINTING/CLEAR FINISHING

To be read with Preliminaries/General Conditions.

COATING SYSTEMS

110 EMULSION PAINT GENERALLY

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Surfaces: as indicated on drawings.
  - Preparation: as clause 400.
- Initial coats: None.
- Number of coats: 1.
- Undercoats: As recommended by manufacturer.
  - Number of coats: 2.
- Finishing coats: Washable 100% pure acrylic paint.
  - Number of coats: 2 unless otherwise recommended by manufacturer.

110A HYGIENIC ACRYLIC BASED PAINT GENERALLY

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Surfaces: as indicated on drawings.
  - Preparation: as clause 400.
- Description: acrylic, water-based coating that cures to a tough, hard wearing, impact resisting and durable coating that resists the growth of mould or bacteria. Hygiene acrylic based emulsion paint to be with low VOC in order to insure good indoor air quality. It shall have very good opacity, outstanding washability and levelling. It shall free of Alkyl Phenol Ethoxylate (APEO) and formaldehyde.
  - Primer coat: one coat acrylic primer. Vol. solids: 25±2 %
  - Filler coat: two coats, as recommended by manufacturer.
  - Topcoat: Two coats as recommended by manufacturer. Vol. solids: 36±2 %
  - Minimum recommended physical Properties:
  - VOC content: 29.75 g/l (US EPA 24)
  - Crack Bridging ability: Up to 1mm according to Vinci method.
  - Resistance to household chemicals/Alkali Resistance: No change shall be observed when tested to relevant BS standard
  - Washability/Scrub Resistance: >15,000 scrubs (DIN 53778)
  - Hazardous Chemicals:
  - Free from:
    - Heavy Metals (ICP-AES)
    - Formaldehyde (UV Spectroscopy)
    - Pthalates (GCMS)
  - Anti-fungal Rating: Rating=1-2 after on average 56 days at exposure on 3 different substrates (BS 3900: Part G6)
  - Anti-microbial activity: Value = 4.8 to 6.3 (JIS Z 2801:2000)
  - Surface spread of Flame: Class 1 to BS 476
  - Smoke Density: Class A

110B PURE ACRYLIC PAINT GENERALLY

- Manufacturer: Submit proposals.

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  - Product reference: Submit proposals.
- Surfaces: as indicated on drawings.
  - Preparation: as clause 400.
- Initial coats: one coat acrylic primer. Vol. solids: 25±2 %.
- Number of coats: 1.
- Filler Coat: As recommended by manufacturer Vol. solids: 38±2%.
  - Number of coats: 2.
- Finishing coats: pure acrylic as recommended by manufacturer. Vol. solids: 38±2%.
  - Number of coats: 2 coats.

175A PROTECTIVE COATING ANTI-CARBONATION PAINT

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Surfaces: walls and ceilings where indicated.
- Description: Elastomeric Anti-Carbonation Coating on smooth concrete vertical surfaces (walls and columns) and ceilings: Flexible two-coat system 100% acrylic coating required to provide protection against ingress of carbon dioxide and chloride ion ingress, with anti-fungal and anti-algae properties. Anti-carbonation coating should be breathable, with excellent durability, fade resistance and resistance to cracking, peeling and chipping while bridging hair line cracks.
- Where indicated, anti-carbonation paint to have high colour light reflective value (LRV) as recommended by manufacturer to meet requested light reflectance.
- Coating system shall comprise the following:
  - Primer: 1x Acrylic copolymer semi-pigmented penetrating Primer. DFT: 20- 30 µm.
  - Filler: Acrylic Copolymer Putty filler for concrete/render. Thickness: As needed, Vol. solids: 65 ±2 %.
  - Topcoat: Smooth finish: 2 x 100% pure acrylic anti-carbonation smooth finish shall be water borne VOC compliant cross-linked technology with superior UV resistance and minor crack resistant capability. DFT 30 µm/coat. Vol. solids: 42±2 %.
- Properties
  - VOC content: 30 g/l (US EPA 24).
  - Determination of Carbon Dioxide (BS EN 1062-6): Equivalent Air Layer ?Thickness: 600m, Equivalent of 400mm concrete: 155 cm
  - Determination of Moisture Resistance (EN ISO 7783-1): Equivalent Air Layer Thickness: 0.500m (avg).
  - Determination of Liquid Water Transmission (BS EN 1602-3): LW Transmission Rate: 0.006 kg/m².h0.5.
  - Determination of Chloride Ion Diffusion (Vinci Method): No penetration observed after more than 4000 days.
  - Crack bridging ability (to BS EN 1602-7): Up to 3.00mm (Class A1 as per Method A to BS EN 1062-7).
  - Reduction in Water Absorption: 100 %?
  - Determination of Colour Retention after 2500 hrs ?Accelerated weathering: No Colour change or visible defect, i.e: cracking, chalking or blistering
  - Abrasion Resistance (ASTM D4060): 20 mg/100 cycle (Grade C17 Wheel).
  - Elongation-Tensile strength at break (to ASTM C412): 2.85 N.mm², 50%.

195A HIGH BUILD SELF-LEVELLING, SOLVENT FREE, HEAVY-DUTY EPOXY COATING-ALSO SUITABLE FOR FOOD PREPARATION AREAS GENERALLY

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.

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- Surfaces: as indicated on drawings.
  - Preparation: Wash down and degrease.
- First Coat:
  - One coat transparent, two component epoxy primer / sealer, vol. solids 98 ± 2% Thickness 150 microns DFT, VOC: 70 gm/L
- Top coat:
  - One coat Solvent Free, high solids epoxy based self-levelling coating, vol. solids 98 ± 2%,thickness 4000 microns dft (4mm),
- System minimum required physical properties:
  - Compressive Strength: 73 N/mm² (ASTM C579)
  - Tensile Strength: 14 N/mm² (ASTM C307)
  - Flexural Strength: 24 N/mm² (ATM C580)
  - Shore "A" Hardness: 96 average (ASTM D2240 - 1996)
  - Shore "D" Hardness: 75 (ASTM D2240 - 1996)
  - Bond Strength to concrete: 2N/mm² (ASTM D 4541)
  - Crack Bridgability : 1.4 mm (ASTM C836)
  - Water Absorption: 0.04% (ASTM C 413-01-1996)
  - Abrasion Resistance: 96mg (ASTM D4060/cs 17 1000 cycles)
  - Impact Resistance: No sign of cracks ASTM D 2794

195B HIGH BUILD, SOLVENT FREE, POLYURETHANE TRAFFIC DECK COATING AND WHERE INDICATED

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Surfaces: floor traffic coating.
  - Preparation: Wash down and degrease.
- Initial Coat/Primer: One coat of a transparent, two component epoxy primer / sealer, vol. solids 98 2%, Thickness 150 microns DFT, VOC: 70 gm/L (US EPA Method 24)
- Middle Coat: One coat of a Solvent Free, high solids Polyurethane coating, vol. solids 100 ± 2%, Thickness 1600 microns (800 microns per coat),
- Traction Layer: One layer of Non Slip Aggregates, washed, graded hard wearing, durable quartz aggregates.
- Finishing Coat:
- Ramp Areas: Two coats of a two component, high solids, flexible, aliphatic polyurethane topcoat, vol. solids 91 ± 2%, thickness 70 microns DFT per coat, VOC: 84 gm/L (US EPA Method 24)
  - One additional coat of a two component, high solids, flexible, aliphatic polyurethane topcoat, vol. solids 91 ± 2%, thickness 70 microns DFT, VOC: 84 gm/L
- Test Properties as per ASTM C 957:
  - Weight loss of base coat, max % 0.05 % (ASTM C1250)
  - Low temperature crack bridging 3 mm (ASTM C1305)
  - Chemical resistance, min, avg % tension retention (ASTM D471)
  - Water exposure 84%
  - Ethylene glycol exposure 100%
  - Mineral spirits exposure 49%.
  - Weathering resistance and recovery from elongation, min % (ASTM C957)
  - Recovery from elongation, initial 92%
  - Tensile retention- 100%
  - Elongation retention 93%
  - Abrasion resistance, 21 mg (ASTM C 501)

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- Additional Test Properties:
  - Chemical resistance as per ASTM D 1308
  - Acid and Alkali resistance as per ASTM D 543 – 100%
  - Tear resistance as per ASTM D 624 – 52 N/m
  - Pull of strength as per ASTM D 4541 – 2 N/mm²
- ROAD MARKING (THERMOPLASTIC): Standard: Road Safety Markings Association standard specification document for road marking and road studs.
  - Colour: as selected by Engineer.
  - Retroreflectivity to BS EN 1436: Class R2.

195C HIGH BUILD, SOLVENT FREE, EPOXY BASED TOPCOAT FOR WALLS AND CEILINGS GENERALLY

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Surfaces: where indicated on drawings.
  - Preparation: Wash down and degrease.
- Initial Coat/Primer: One coat of a transparent, solvent free two component epoxy primer / sealer, vol. solids 98 ± 2%, Thickness 150 microns DFT.
- Finishing Coat: One finishing coat of a two component, high solids, solvent free coating, vol. solids 98 ± 2%, thickness 150 microns dft, Coating to be suitable for food preparation areas.
- Coating system to be independently tested for following properties: after 28 days curing
  - Compressive Strength: not less than 90 N/mm² (ASTM C579)
  - Tensile Strength: not less than 8 N/mm² (ASTM C307)
  - Crack bridging ability: 1.62(ASTM D 638-10/C1305)
  - Water Absorption: 0.0 (ASTM C413)

195D HYGIENIC POLYURETHANE COATING SYSTEM GENERALLY

- Polyurethane coating system shall withstand rigorous cleaning with fumigants, peroxides and other aggressive chemical cleaners. Highly durable, abrasion resistant and anti-microbial. Coating system shall control the growth and spread of microbes by incorporating non-leaching anti-microbial additives in all system layers. It shall tolerate thermal movement without cracking, splitting or flaking. Coating shall be easily cleaned and resistant to fumigants, peroxides and other aggressive cleaners, chemicals and abrasives. It need to be colour and UV stable.
- Usage:
  - Coating system to be categorized for cat. 3 or 4 ACDP clean rooms/laboratories.
- Fire performance:
  - BS 476–7: Class 1.
  - BS 476–6: Designated 0.
- Operational temperature:
  - Once applied and cured, coating shall be stable in temperatures between -15°C and +90°C.
- Primer: manufacturer's recommended White Primer, at 7-9 m²/ litre. Min. DFT 120 microns
- Undercoat: manufacturer's recommended Undercoat, at 9-11 m²/ litre - For application of the system on plaster and plasterboard in dry areas only. For other substrates and/or wet areas only two topcoats are required. Min. DFT90 microns.
- Topcoat: 2 coats each at 8-10 m²/litre. Min. DFT 180 microns
- Where indicated for heavy traffic and added durability, coating to receive fiberglass reinforcement at 1m²/litre, incorporating one layer of 150g/m² chop strand mat and one layer of 50 g/m² fiberglass standard tissue, followed by 1 midcoat at 4.5 m²/litre.
- Scrub and abrasion resistance:
  - Scrub resistance (tested to ASTM D2486) - 4000+ cycles.

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- Abrasion resistance (tested to ASTM D1044, D3389) - 6000 cycles.

GENERALLY

210 COATING MATERIALS

- Manufacturers: Obtain materials from any of the following:
  As determined by Engineer.
- Selected manufacturers: Submit names before commencement of coating work.

215 HANDLING AND STORAGE

- Coating materials: Deliver in sealed containers, labelled clearly with brand name, type of material and manufacturer's batch number.
- Materials from more than one batch: Store separately. Allocate to distinct parts or areas of the work.

220 COMPATIBILITY

- Coating materials selected by contractor:
  - Recommended by their manufacturers for the particular surface and conditions of exposure.
  - Compatible with each other.
  - Compatible with and not inhibiting performance of preservative/fire retardant pretreatments.

240 SURFACES NOT TO BE COATED

- As indicated on drawings and finish schedule.

280 PROTECTION

- 'Wet paint' signs and barriers: Provide where necessary to protect other operatives and general public, and to prevent damage to freshly applied coatings.

320 INSPECTION BY COATING MANUFACTURERS

- General: Permit manufacturers to inspect work in progress and take samples of their materials from site if requested.

PREPARATION

400 PREPARATION GENERALLY

- Standard: In accordance with BS 6150.
- Refer to any pre-existing CDM Health and Safety File.
- Refer to CDM Construction Phase Plan where applicable.
- Suspected existing hazardous materials: Prepare risk assessments and method statements covering operations, disposal of waste, containment and reoccupation, and obtain approval before commencing work.
- Preparation materials: Types recommended by their manufacturers and the coating manufacturer for the situation and surfaces being prepared.
- Substrates: Sufficiently dry in depth to suit coating.
- Efflorescence salts: Remove.
- Dirt, grease and oil: Remove. Give notice if contamination of surfaces/ substrates has occurred.
- Surface irregularities: Remove.
- Joints, cracks, holes and other depressions: Fill flush with surface, to provide smooth finish.
- Dust, particles and residues from preparation: Remove and dispose of safely.
- Water based stoppers and fillers:
  - Apply before priming unless recommended otherwise by manufacturer.
  - If applied after priming: Patch prime.
- Oil based stoppers and fillers: Apply after priming.

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- Doors, opening windows and other moving parts:
  - Ease, if necessary, before coating.
  - Prime resulting bare areas.

420 FIXTURES AND FITTINGS

- Removal: Before commencing work remove: Coverplates, grilles, wall clocks, and other surface mounted fixtures.
- Replacement: Refurbish as necessary, refit when coating is dry.

425 IRONMONGERY

- Removal: Before commencing work: Remove ironmongery from surfaces to be coated.
- Hinges: Remove.
- Replacement: Refurbishment as necessary; refit when coating is dry.

471 PREPRIMED WOOD

- Areas of defective primer: Take back to bare wood and reprime.

481 UNCOATED WOOD

- General: Provide smooth, even finish with arrises and moulding edges lightly rounded or eased.
- Heads of fasteners: Countersink sufficient to hold stoppers/fillers.
- Resinous areas and knots: Apply two coats of knotting.

490 PREVIOUSLY COATED STEEL

- Defective paintwork: Remove to leave a firm edge and clean bright metal.
- Sound paintwork: Provide key for subsequent coats.
- Corrosion and loose scale: Take back to bare metal.
- Residual rust: Treat with a proprietary removal solution.
- Bare metal: Apply primer as soon as possible.
- Remaining areas: Degrease.

500 PREPRIMED STEEL

- Areas of defective primer, corrosion and loose scale: Take back to bare metal. Reprime as soon as possible.

511 GALVANIZED, SHERARDIZED AND ELECTROPLATED STEEL

- White rust: Remove.
- Pretreatment: Apply one of the following:
  - Mordant solution to blacken whole surface.
  - Etching primer recommended by coating system manufacturer.

521 UNCOATED STEEL - MANUAL CLEANING

- Oil and grease: Remove.
- Corrosion, loose scale, welding slag and spatter: Remove.
- Residual rust: Treat with a proprietary removal solution.
- Primer: Apply as soon as possible.

531 UNCOATED STEEL - BLAST CLEANING

- Oil and grease: Remove.
- Blast cleaning:
  - Atmospheric conditions: Dry.
  - Abrasive: Suitable type and size, free from fines, moisture and oil.
  - Surface finish: To BS EN ISO 8501-1, preparation grade Sa 2½.

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- Primer: Apply as soon as possible and within four hours of blast cleaning.

560 UNCOATED CONCRETE
- Release agents: Remove.

570 UNCOATED MASONRY/ RENDERING
- Loose and flaking material: remove.

580 UNCOATED PLASTER
- Nibs, trowel marks and plaster splashes: Scrape off.
- Overtrowelled 'polished' areas: Key lightly.

590 UNCOATED PLASTERBOARD
- Depressions around fixings: Fill with stoppers/ fillers

601 UNCOATED PLASTERBOARD - TO RECEIVE TEXTURED COATING
- Joints: Fill, tape and feather out with materials recommended by textured coating manufacturer.

611 WALL COVERINGS
- Retained wall coverings: Check that they are in good condition and well adhered to substrate.
- Previously covered walls: Wash down to remove paper residues, adhesive and size.

622 ORGANIC GROWTHS
- Dead and loose growths and infected coatings: Scrape off and remove from site.
- Treatment biocide: Apply appropriate solution to growth areas and surrounding surfaces.
- Residual effect biocide: Apply appropriate solution to inhibit re-establishment of growths.

645 SEALING OF INTERNAL MOVEMENT JOINTS
- General: To junctions of walls and ceilings with architraves, skirtings and other trims.
- Sealant: Water-borne acrylic.
  - Manufacturer: Submit proposals.
    Product reference: Submit proposals.
  - Preparation and application: As section Z22.

APPLICATION

711 COATING GENERALLY
- Application standard: In accordance with BS 6150, clause 9.
- Conditions: Maintain suitable temperature, humidity and air quality during application and drying.
- Surfaces: Clean and dry at time of application.
- Thinning and intermixing of coatings: Not permitted unless recommended by manufacturer.
- Overpainting: Do not paint over intumescent strips or silicone mastics.
- Priming coats:
  - Thickness: To suit surface porosity.
  - Application: As soon as possible on same day as preparation is completed.
- Finish:
  - Even, smooth and of uniform colour.
  - Free from brush marks, sags, runs and other defects.
  - Cut in neatly.
- Doors, opening windows and other moving parts: Ease before coating and between coats.

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720 PRIMING JOINERY

- Preservative treated timber: Retreat cut surfaces with two flood coats of a suitable preservative before priming.
- End grain: Coat liberally allow to soak in, and recoat.

730 WORKSHOP COATING OF CONCEALED JOINERY SURFACES

- General: Apply coatings to all surfaces of components.

731 SITE COATING OF CONCEALED JOINERY SURFACES

- General: After priming, apply additional coatings to surfaces that will be concealed when fixed in place.
  - Components: as indicated on drawings.
  - Additional coatings: One undercoat.

740 CONCEALED METAL SURFACES

- General: Apply additional coatings to surfaces that will be concealed when component is fixed in place.
  - Components: as indicated on drawings.
  - Additional coatings: Black paint to BS 1070.

751 STAINING WOOD

- Primer: Apply if recommended by stain manufacturer.
- Application: Apply in flowing coats and brush out excess stain to produce uniform appearance.

760 VARNISHING WOOD

- First coat: Thin with white spirit.
  - Brush well in and lay off avoiding aeration.
- Subsequent coats: Provide light key and smooth along the grain between coats.

770 EXTERNAL DOORS

- Bottom edges: Prime and coat before hanging doors.

800 GLAZING

- Etched, sand blasted and ground glass: Treat or mask edges before coating to protect from contamination by oily constituents of coating materials.

810 WATER REPELLENT

- Application: Liberally flood surface, giving complete and even coverage.

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M61 INTUMESCENT COATINGS FOR FIRE PROTECTION OF STEELWORK

To be read with Preliminaries/General Conditions.

PROTECTIVE COATING SYSTEMS

110 PERFORMANCE REQUIREMENTS

- Assemblies: Provide fire protection, including auxiliary materials, in accordance with requirements of each fire-resistance design and manufacturer's written instructions.

- Source Limitations: Obtain fire protection from single source.

- Fire-Resistance Characteristics: Provide intumescent paint system with the following fire resistance duration as determined by testing identical products in accordance with ASTM E119 or UL 263 by UL, Warnock Hersey, BRE, or Warrington Certifire or by another testing standard and inspecting agency acceptable to authorities having jurisdiction. Identify products with appropriate markings of applicable testing agency.

    1. Fire Resistance Rating: As indicated in FLS report.
    2. Steel members are to be considered unrestrained unless specifically noted otherwise.

111A INTUMESCENT PAINT SYSTEM

- GENERAL

- Intumescent Fire-Resistive Coating system: Manufacturer's standard, factory-mixed, multicomponent system consisting of primer, intumescent base coat and topcoat, and complying with indicated fire-resistance design.
    - Primers and topcoats should be approved and obtained from intumescent paint system manufacturer whose responsibility is to ensure that intumescent paint is compatible for use in respect of both ambient and fire conditions.
    - Corrosion resistant primers, topcoat and coating system shall be in compliance with ISO 12944, approved by intumescent fire protective coating manufacturer for the intended area of application, and complying with required fire-resistance design by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
    - Intumescent coating intended for C5 corrosion category shall be tested to UL 263 and UL 2431 by a qualified testing agency acceptable to authorities having jurisdiction and certified for Exterior use and classification category I-A, unless otherwise approved by Engineer.
    - Typical application:

        Water borne or better intumescent coatings designated for interior environments to ISO 12944 C3 corrosion category, and as per written instructions from manufacturer.
        Solvent borne or better intumescent coatings designated for interior environments to ISO 12944 C4 corrosion category, and as per written instructions from manufacturer.
        Two components epoxy intumescent coatings designated for interior/exterior environments to ISO 12944 C5 corrosion category, and as per written instructions from manufacturer.

    - Thickness: As required for fire-resistance design indicated, measured in accordance with requirements of fire-resistance design.
    - Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

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Flame-Spread Index: 25 or less.
Smoke-Developed Index: 50 or less.

- Structural Steel: Provide the following intumescent paint system over new load-boarding structural steel construction. Intumescent paint system shall consist of the following coats:

  - Corrosion protection primer.
  - Intumescent coating in multiple-coat application according to required thickness.
  - Finish topcoat with high performance paint in the indicated or selected colour.

- Corrosion-Protection Prime Coat: Epoxy based, as per approved primers list from Intumescent paint manufacturer.

  - Primer is certified by manufacturer as compatible with intumescent coat material.
  - Dry film thickness: As per manufacturer's recommendations and complying with ISO12944-5, but not less 75 microns.
    Corrosion protection primer shall be factory applied.
    Application: Airless Spray.

- Intumescent Paint Layer: Thin-film intumescent fire resistive coating for load-bearing structural steel, compatible with primer specified and shall accept a wide range of topcoat finish coatings and comply with the following:

  - Asbestos and chlorine free
  - Activation: Thermal
  - Type: Self-destructive that expands to not less than 40 times film thickness
  - Dry film thickness: In accordance with manufacturer's certified loading data for given hp/a
    Hp: The perimeter of the steel section.
    A: The cross-section area of the steel section.
  - Number of coats: One or more coats based on required thickness and the recommended maximum thickness per coat, as per Intumescent paint manufacturer's recommendations.
  - Product should be listed by UL, Warnock Hersey, BRE, or Warrington Certifire, or any other agency approved by authorities having jurisdiction.

- Topcoat: Acrylic Aliphatic-Polyurethane: Two-Component acrylic resin-based enamel cured with aliphatic polyisocyante applicable on steel surfaces primed with epoxy-based primers and coated with intumescent paint basecoat. Dry enamel film shall exhibit excellent gloss and colour retention, durability, scratch and abrasion resistance and chemical resistance. Topcoat to comply with the following:

  - Corrosion environments to ISO 12944.
  - Binder: Acrylic aliphatic polyurethane.
  - Application: Airless spray.
  - Number of coats and dry Film Thicknesses: As per manufacturer's recommendations complying with ISO 12944-5.
    Color and Gloss: As selected by Engineer from manufacturer's full range.
  - Finish: As approved by Engineer from the following:
- Basic Finish: Definition: reasonably smooth and even. Orange peel, other texture, minor runs and similar minor defects are acceptable.
- Normal Decorative Finish: Definition: Good standard of cosmetic finish generally, when viewed from a distance of 5 meters or more. Minor orange peel or other texture is acceptable.
  High Decorative Finish: Definition: High standard of evenness, smoothness and gloss when viewed from a minimum distance of 2 meters.

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111B AUXILIARY MATERIALS

- Provide auxiliary materials that are compatible with intumescent fire-resistive coating and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in fire-resistance designs indicated.
- Substrate Primers: Primers approved by intumescent fire-resistive coating manufacturer and complying with required fire-resistance design by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
- Reinforcing Fabric: Glass- or carbon-fiber fabric of type, weight, and form required to comply with fire-resistance designs indicated; approved and provided by intumescent fire-resistive coating manufacturer.
- Reinforcing Mesh: Metallic mesh reinforcement of type, weight, and form required to comply with fire-resistance design indicated; approved and provided by intumescent fire-resistive coating manufacturer. Include pins and attachment.
- Topcoat: Suitable for application over intumescent fire-resistive coating; of type recommended in writing by intumescent fire-resistive coating manufacturer for each fire-resistance design.

GENERAL REQUIREMENTS

204 PROJECT CONDITIONS

- Do not apply intumescent paints in rain, fog or mist; when relative humidity exceeds 85 percent; if temperature is less than 3 deg C above the dew point; or to damp or wet surfaces.
- Steel temperature should not exceed 50 deg C. Manufacturer's current application guide lines should be followed for any application above these temperatures.

205 VALIDATION OF MATERIALS

- Project specific evaluation of intumescent coating materials:
  - Standard: In accordance with BS 8202-2, clause 4.
  - Test results: Submit on request.

210 WORKING PROCEDURES

- Standard: In accordance with BS 8202-2.
- Give notice: Before commencing surface preparation and coating application.
- Quality control: Record project specific procedures for surface preparation and coating application.

215 WORKING CONDITIONS

- Environmental Limitations: Do not apply fire protection when ambient or substrate temperature is 10 deg C or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application.
- Steel temperature should not exceed 40 deg C. Manufacturer's current application guidelines should be followed for any application above these temperatures.
- Do not apply intumescent paints in rain, fog or mist; when relative humidity exceeds 85 percent; or to damp or wet surfaces.
- Ventilation: Ventilate building spaces during and after application of fire protection, providing complete air exchanges in accordance with manufacturer's written instructions. Use natural means or, if they are inadequate, forced-air circulation until fire protection dries thoroughly.
- Deliver Intumescent paint materials to the Project site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label, and the following information:
  - Product name of material.
  - Manufacturer's stock number and manufacturing date.
  - Material shelf life should not exceed 6 months.

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- Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 7 degrees Celsius & a maximum temperature of 30 degrees Celsius. If temperature at storage area is likely to exceed 30 degrees Celsius at any point, materials should be stored in air-conditioned storage area.

220 APPLICATOR'S PERSONNEL

- Operatives: Trained/ experienced in anticorrosive and intumescent coatings.
- Evidence of training/ experience: Submit on request.

250 SPRAYED COATING APPLICATION ON SITE

- Standard: In accordance with BS 8202-2.
- Spray drift: Minimize.
- Uncoated areas of steel: as indicated.
- Masking: Protect designated adjacent surfaces.
  - Designated surfaces: as indicated.

260 CONTROL SAMPLES

- General: Carry out sample areas of finished work as follows:
  One column and two adjoining beams as directed by Engineer.
- Approval of appearance: Obtain before commencement of general application.

270 INSPECTION

- Special Inspections: Engage a qualified special inspector to perform the following special inspections:
  - Upon the Engineer's request, samples of the applied intumescent fire protection material shall be randomly selected from approved production batches bearing the applicable classification for independent third-party testing.
  - Testing shall verify compliance with the specified fire-resistance rating and the applicable classification.
  - Any materials found non-compliant shall be removed and replaced at no additional cost to the Employer.

- Quality Control: Wet and Dry Film Thickness (DFT) shall be checked regularly during applications at intervals as instructed by Engineer:

  - To ensure the correct thickness is being applied, frequent measurements shall be taken using a wet film thickness gauge.
  - Take a DFT reading as soon as the Intumescent Paint is fully cured.
    Provide Elcometer 456 or equivalent electromagnetic and electronic gauge type to take DFT thickness. Ensure to deduct thickness of primer from measured thickness.
  - All paint inspection equipment should be calibrated daily at site and calibrated biannually by an approved third-party agency acceptable to authorities having jurisdiction. Calibration certificates should be available for inspection by the Engineer.

- Perform the tests and inspections of completed Work in successive stages as per authorities having jurisdiction and Engineer's requirements. Do not proceed with application of fire protection for the next area until test results for previously completed applications of fire protection show compliance with

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requirements. Tested values must equal or exceed values as specified and as indicated and required for approved fire-resistance design.

- See Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.
- Fire protection will be considered defective if it does not pass tests and inspections.

  - Remove and replace fire protection that does not pass tests and inspections, and retest.
  - Apply additional fire protection, per manufacturer's written instructions, where test results indicate insufficient thickness, and retest.

- Prepare test and inspection reports.

PREPARATION OF SURFACES

315 NEW STEEL - BLAST CLEANING

- Cleaning: Before applying coatings or other surface treatments, clean substrates of any substances that could impair adhesion of intumescent paint systems.
  - Schedule cleaning and painting application so dust and other contaminants will not fall on wet, newly painted surfaces
  - Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified:
  - Prior to applying primer, the steel surfaces shall be blast cleaned to Swedish Standard SA 2.5 (ISO 8501-1) or SSPC-SP10 near white blast cleaning, and in compliance with ISO 12944-8.
  - For application to galvanized steel substrates, surface shall be brush off blast cleaned to SA 1 (ISO 8501-1) or SSPC-SP7 and as per paint system manufacturer recommendations.
- Cover other work subject to damage from fallout or overspray of fire protection materials during application.
- Clean substrates of substances that could impair bond of fire protection.
- Generally, retain first paragraph below.
- Prime substrates where included in fire-resistance design and where recommended in writing by intumescent fire-resistive coating manufacturer unless compatible shop primer has been applied and is in satisfactory condition to receive fire protection.
- Retain paragraph below unless fire protection is neither visible nor important to Project's appearance.
- For applications visible on completion of Project, repair substrates to remove surface imperfections that could affect uniformity of texture and thickness in finished surface of fire protection. Remove minor projections and fill voids that would telegraph through fire-resistive products after application.

APPLICATION OF COATINGS

495A EXAMINATION

- Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for substrates and other conditions affecting performance of the Work and in accordance with each fire-resistance design.

  - Verify that substrates are free of dirt, oil, grease, release agents, rolling compounds, mill scale, loose scale, incompatible primers, paints, and encapsulants, or other foreign substances capable

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of impairing bond of fire protection with substrates under conditions of normal use or fire exposure.
  - Verify that objects penetrating fire protection, including clips, hangers, support sleeves, and similar items, are securely attached to substrates.
  - Verify that substrates receiving fire protection are not obstructed by ducts, piping, equipment, or other suspended construction that will interfere with fire protection application.
- Conduct tests in accordance with intumescent fire-resistive coating manufacturer's written instructions to verify that substrates are free of substances capable of interfering with bond.
- Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- Proceed with installation only after unsatisfactory conditions have been corrected and surfaces to receive paint are thoroughly dry.
- Start of painting will be construed as Applicator's acceptance of surfaces and conditions within a particular area.

495B APPLICATION

- Apply intumescent coating system in according with manufacturer's written current application guides. Use applicators and techniques best suited for substrate and type of material being applied.
- Material Preparation: Mix and prepare paint materials according to manufacturer's written instructions.
  - Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
  - Stir material before application to produce a mixture of uniform density, and as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
- Construct fire protection assemblies that are identical to fire-resistance design indicated and products as specified, tested, and substantiated by test reports; for thickness, primers, topcoats, finishing, and other materials and procedures affecting fire protection Work.

- Comply with intumescent fire-resistive coating manufacturer's written instructions for mixing materials, application procedures, and types of equipment used to mix, convey, and apply fire

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protection, as applicable to particular conditions of installation and as required to achieve fire-resistance ratings indicated.

- Coordinate application of fire protection with other construction to minimize need to cut or remove fire protection.

  - Do not apply coatings over dirt, rust, scale, grease, moisture, scuffed surfaces or conditions indicated as unacceptable in manufacturer's written instructions or to surfaces that are otherwise detrimental to forming an acceptable coating.
  - Do not begin applying fire protection until clips, hangers, supports, sleeves, and other items penetrating fire protection are in place.
  - Defer installing ducts, piping, and other items that would interfere with applying fire protection until application of fire protection is completed.
- Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration

  - Do not apply succeeding coats until the previous coat has cured as recommended by the manufacturer.
  - If intumescent coat shows through the finished topcoat, apply additional coats until paint film is of uniform finish, color and appearance.
  - Give special attention to ensure that edges, corners, crevices, welds and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
  - Any damage to the factory applied priming coat shall be repaired and touched up, in compliance with recommendations of priming coat manufacturer. After the application of the prime coat, application of intumescent paint shall not commence without written approval by the Engineer.
  - Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, does not deform or feel sticky under moderate thumb pressure and where applying another coat of paint does not cause the undercoat to lose adhesion.
- Install auxiliary materials as required, as detailed, and in accordance with fire-resistance design and intumescent fire-resistive coating manufacturer's written instructions for conditions of exposure and intended use. For auxiliary materials, use attachment and anchorage devices of type recommended in writing by intumescent fire-resistive coating manufacturer.

- Spray apply fire protection to maximum extent possible. After the spraying operation in each area, complete the coverage by trowel application or other placement method recommended in writing by intumescent fire-resistive coating manufacturer.

- Extend fire protection in full thickness over entire area of each substrate to be protected.

- Install body of fire protection in a single course unless otherwise recommended in writing by intumescent fire-resistive coating manufacturer.

- Provide a uniform finish complying with description indicated for each type of fire protection material and matching finish approved for required mockups.

- Coating Thickness: Apply materials at not less and not more than manufacturer's recommended spreading rate for the surface to be coated. Provide the total dry film thickness of the entire system as recommended by the manufacturer to provide surface burning characteristics and fire resistance rating specified, but not less than thickness specified in this Section.

  - No topcoat should be applied until intumescent paint has achieved required DFT (dry film thickness) in accordance with HP/A on certified loading chart from manufacturer.

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- For intumescent coatings, dry film thickness should be measured in accordance with the acceptance criteria outlined in section 4.7 Association for Specialist Fire Protection (ASFP) technical guidance document 11.

- Completed work: Match approved samples for color, texture and coverage. Remove, refinish or repaint work not complying with specified requirements.

- Do not install enclosing or concealing construction until after fire protection has been applied, inspected, and tested and corrections have been made to deficient applications.

- Finishes: Where indicated, apply fire protection to produce the following finishes:

- Manufacturer's Standard Finishes: Finish in accordance with manufacturer's written instructions for each finish selected.

- Spray-Textured Finish: Finish left as spray applied with no further treatment.

- Rolled, Spray-Textured Finish: Even finish produced by rolling spray-applied finish with a damp paint roller to remove drippings and excessive roughness.

495 WARRANTY

- General Warranty: The special warranty specified in this Article shall not deprive the Employer of other rights the Employer may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
- Full System Warranty: Provide full system warranty in which Manufacturer, contractor and Installer are jointly and severally responsible and agree to repair or replace, without limitations, intumescent paint system that fails within the specified warranty period.
  Failure includes but shall not be limited to the following:

  - Peeling or blistering of paint.
  - Failure to protect against fire for the specified time.
  - Cracking of paint film.
  - Crazing of paint film.
  - Change in color of finish topcoat.
- Warranty period for Fire Performance: 20 years from date of Substantial Completion.

- Warranty for Corrosion Resistance: The fire-resistant paint system (including primer, intumescent paint and top finish coat) shall provide corrosion protection to first maintenance for the warranty period specified hereafter.

530 RECORDS OF INTUMESCENT APPLICATION

- On completion of intumescent work, submit:
  - Accurate surface preparation, coating and intumescent application records.
  - Fire resistance certificates.
  - Intumescent manufacturer's recommendations for maintenance and overcoating.

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PART 3 SPECIFICATION CLAUSES SPECIFIC TO N10

100.010 QUALITY ASSURANCE

- Source Limitations: Obtain fire extinguishers and cabinets through one source from a single manufacturer.
- NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Standard for Portable Fire Extinguishers."
- Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to Engineer and authorities having jurisdiction.
    - Provide extinguishers listed and labeled by FM Global.

100.020 COORDINATION

- Coordinate size of cabinets to ensure that type and capacity of fire extinguishers indicated and provided by Employer under separate Contract are accommodated.

110.000 PRODUCTS

110.010 MATERIALS

- Cold-Rolled Steel Sheet: Carbon steel, complying with ASTM A 1008/A 1008M, commercial steel (CS) Type B.
- Aluminum: Alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated, and as follows:
    - Sheet: ASTM B 209M (ASTM B 209).
    - Extruded Shapes: ASTM B 221M (ASTM B 221).
- Stainless-Steel Sheet: ASTM A 666, Type SS304 / SS316.
- Copper-Alloy Sheet, Brass: ASTM B 36/B 36M, alloy UNS No. C26000 (cartridge brass, 70 percent copper).
- Copper-Alloy Sheet, Bronze: ASTM B 36/B 36M, alloy UNS No. C28000 (muntz metal, 60 percent copper).

110.020 PORTABLE FIRE EXTINGUISHERS

- General: Provide fire extinguishers of type, size, and capacity for each cabinet and other locations indicated.

- Multipurpose Dry-Chemical Type: UL-rated 4-A:60-B:C, 4.5-kg (10-lb) nominal capacity, in enameled-steel container.

- Carbon-Dioxide Type: UL-rated 10-B:C, 4.5-kg (10-lb) nominal capacity, in manufacturer's standard enameled-metal container.

- Class K type: Stored Pressure Design, wet chemical, UL Rating 2-A:K, capacity 1.6 gallon (6 l), all stainless steel cylinder and valve construction, exclusive crevice free, but welded cylinder, tested on commercial deep fat fryers to ANSI / UL, 711 test protocol and safe to use on class C fires, class 2A rated to meet fire code occupancy hazard requirements, temperature range +40°F to 120°F, and meets NFPA-10, class K standard. In addition, the following characteristics need to be included;
    - Clear instruction label using graphics to show steps required to operate extinguisher
    - Easy-to-pull safety pin
    - Tough impact resistant metal valve, handle & lever
    - UL approved wall hanger
    - Corrosion resistant cylinder & valve assembly

110.030 WHEELED FIRE EXTINGUISHERS

- General: Provide wheeled fire extinguishers of type, size, and capacity for locations indicated.

- Carriage: Fabricate from enameled-steel pipe, complete with hanger assembly, long-range nozzle, semipneumatic solid-rubber tires, and the following:

    - Hose: 4.6 m (15 feet).

- Pressurized, AFFF-Foam Type: UL-rated 20-A:160-B, 125- L (33-gal.) nominal capacity, in stainless-steel container with pressure-indicating gage.

110.040 ACCESSORIES

- Mounting Brackets: Manufacturer's standard steel, designed to secure extinguisher, of sizes required for types and capacities of extinguishers indicated, with plated or baked-enamel finish.

    - Provide brackets for extinguishers not located in cabinets.
    - Provide brackets for extinguishers located in cabinets.

- Identification: Provide lettering to comply with authorities having jurisdiction for letter style, color, size, spacing, and location. Locate as indicated by Engineer.

    - Identify bracket-mounted extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to wall surface.
    - Identify fire extinguisher in cabinet with the words "FIRE EXTINGUISHER" applied to door.

        - Application Process: Vinyl letters.
        - Lettering Color: Red.

110.050 COLORS AND TEXTURES

- Colors and Textures: As selected by Engineer from manufacturer's full range for these characteristics.

110.060 FINISHES, GENERAL

- Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

- Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

- Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

- ALUMINUM FINISHES

  - Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

  - Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Apply baked enamel complying with paint manufacturer's specifications for cleaning, conversion coating, and painting.

    - Organic Coating: Thermosetting, modified-acrylic enamel primer/topcoat system complying with AAMA 603.8 except with a minimum dry film thickness of 0.04 mm, medium gloss.
    - Color: As selected by Engineer from manufacturer's full range.

  - Polyester Powder Coating: Approved type to meet the requirements of AAMA 603 or BS 6496 and BS EN 13438, consisting of powder particles of resinous material and additives to improve performance. The coating is to be electrostatically sprayed on to produce a hard, durable coating.

    - Minimum dry film thickness: 60 microns.
    - Color: As selected by Engineer from manufacturer's full range.
    - Surface finish: gloss.

110.070 STEEL FINISHES

- Surface Preparation: Clean surfaces of dirt, oil, grease, mill scale, rust, and other contaminants that could impair paint bond using manufacturer's standard methods.

- Factory Priming for Field-Painted Finish: Apply shop primer specified below immediately after surface preparation and pretreatment.

  - Shop Primer: Manufacturer's or fabricator's standard, fast-curing, lead- and chromate-free, universal primer, selected for resistance to normal atmospheric corrosion, for compatibility with substrate and field-applied finish paint system indicated, and for capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.

- Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 0.05 mm.

- Color and Gloss: As selected by Engineer from manufacturer's full range.

- Polyester Powder Coating: Approved type to meet the requirements of AAMA 603 or BS 6496 and BS EN 13438, consisting of powder particles of resinous material and additives to improve performance. The coating is to be electrostatically sprayed on to produce a hard, durable coating.

  - Minimum dry film thickness: 60 microns.
  - Color: As selected by Engineer from manufacturer's full range.
  - Surface finish: gloss.

120.000 EXECUTION

120.010 EXAMINATION

- Examine walls and partitions for suitable framing depth and blocking where recessed and semirecessed cabinets are to be installed.

- Examine fire extinguishers for proper charging and tagging.

  - Remove and replace damaged, defective, or undercharged units.

- Proceed with installation only after unsatisfactory conditions have been corrected.

120.020 INSTALLATION

- Comply with manufacturer's written instructions for installing fire-protection specialties.

- Install in locations and at mounting heights indicated or, if not indicated, at heights acceptable to authorities having jurisdiction.

N10B GENERAL FIXTURES/ FURNISHINGS/ EQUIPMENT

To be read with Preliminaries/General Conditions.

PRODUCTS

110 PURPOSE MADE CABINETS, AND THE LIKE AS INDICATED ON DRAWINGS AND FURNITURE MANUAL

- Manufacturer: Submit proposals to Engineer's approval.
- Standard: To BS EN 13150.
- Timber: To BS EN 942.
  - Species: plastic laminate on MDF. High density fibreboard to receive natural wood veneer of species as indicated in finishes manual.
  - Appearance class: Not applicable.
  - Moisture content on delivery: 12 to 16%.
- Wood based boards: Medium density fibreboard to BS EN 622-5, type MDF H, formaldehyde class E1 to BS EN 622-1, 18 mm thick.
- Metal: Chrome finished hinges to cabinet doors and chrome finished handles, unless otherwise indicated in Finishes manual and on drawings.
  - Grade: N/A.
- Other materials: none.
- Finishes: as shown in manual.
- Adhesive: To BS EN 204, durability class D2.
- Fixings: as shown on drawings.
  - Fasteners: stainless steel 304.
- Joinery workmanship: As section Z10.
- Metalwork materials and workmanship: As section Z11.
- Other requirements: none.

170 BENCHES AND LINKED SEATS FOR CHANGING ROOMS

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Seat/ Back:
  - Material: Hardwood.
  - Finish/ Colour: Clear lacquer.
- Frame:
  - Material: Aluminium.
  - Finish/ Colour: Powder coated, black.
- Fixing: To manufacturer's specification.
- Fittings/ Other requirements: Not required.

171 FIXED SEATING where indicated

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Dimensions
  - Seat height: Manufacturer's standard.
  - Seat spacing (lateral): Manufacturer's standard.
  - Row spacing: Manufacturer's standard.
- Seat/ Back:
  - Material: Upholstered softwood.

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  - Finish/ Colour: Clear lacquer.
- Frame:
  - Material: Steel.
  - Finish/ Colour: Powder coated, black.
- Fixing: To manufacturer's specification.
- Accessories/ Other requirements: Armrest and as indicated in the FF&E manual.

188 BATHROOM AND WASHROOM EQUIPMENT

- Item: Soap dispenser, toilet roll holder, towel rail and as indicated in the sanitary manual.
- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Material: Stainless steel unless otherwise indicated in the sanitary manual.
- Finish/ Colour: Brushed unless otherwise indicated in the sanitary manual.
- Fixing: Plugged and screwed to wall otherwise indicated in the sanitary manual.
- Other requirements: as indicated in the sanitary manual.

200A WORKTOPS WHERE INDICATED IN FINISHES MANUAL

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Material: Plastic Laminate covered particleboard.
- Finish/ Colour: as indicated.
- Dimensions: as indicated.
  - Plan size: as indicated.
  - Thickness: as indicated but not less than 18 mm.
  - Height: as indicated.
- Front edges Post formed.
  - Cut edges: Plastics 'T' section.
- Support: Legs
- Cutouts: Manufacturer's standard.
- Integral accessories: Support legs.

200C WORKTOPS WHERE INDICATED IN FINISHES MANUAL

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Material: Solid surface.
- Homogeneous, non-porous solid surface material manufactured from a blend of acrylic polymer and natural mineral fillers.
- Finish/ Colour: as indicated.
- Dimensions: as indicated.
  - Plan size: as indicated.
  - Thickness: as indicated but not less than 18 mm.
  - Height: as indicated.
- Front edges Radiused.
  - Cut edges: Stainless steel strip.
- Support: Legs
- Cutouts: Manufacturer's standard.
- Integral accessories: Support legs.
- Thermoformable, allowing fabrication into curved and complex shapes.

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210 COAT RACKS TO LOCKER AREAS

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Arrangement: Double sided.
- Mounting: Wall fixed.
- Dimensions:
  - Overall length: as indicated.
  - Overall height: as indicated.
- Material: Steel frame.
  - Finish/ Colour: Powder coated, Grey.
- Integral accessories: Hangers.

220 LOCKERS GENERALLY

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Standard: To BS 4680.
  - Test level: Heavy duty.
- Dimensions:
  - Overall length: as indicated.
  - Overall height: as indicated.
- Arrangement: as indicated.
- Material: Sheet steel.
  - Finish/ Colour: Powder coated, white unless otherwise indicated.
- Lock type: Digital combination lock.
- Fittings: Coat hooks or shelves as indicated.
- Other requirements: None.

230 CURTAIN RAILS

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Dimensions:
  - Opening dimensions: as indicated.
  - Overall length: as indicated.
- Material: Aluminium.
- Finish/ Colour: Powder coated white RAL 9010 unless otherwise indicated.
- Fixing: Plugged and screwed to wall.
- Operation: Manual.
- Accessories: None.

235 CURTAINS WHERE INDICATED

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Standard: To BS 5867-1 and -2.
- Dimensions:
  - Width: as indicated.
  - Drop: as indicated.
- Heading style: Deep pleat.
- Material:
  - Fabric: Polyester and cotton blend.
  - Colour/ Pattern: as indicated.

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- Lining:
  - Fabric: Polyester and cotton blend.
  - Colour: as indicated.
- Integral accessories: Pelmets.

242 BLINDS WHERE INDICATED

- Standard: To BS EN 13120.
- Type: Vertical louvre.
- Material: Fabric.
  - Finish/ Colour: as indicated in the finishes manual.
- Operation: Manual, stainless steel ball chain.
- Operating effort: Class 1.
- Testing: Solar transmittance and shall withstand misuse.
- Mechanism endurance: Class 1.
- Accessories/ Other requirements: Maintenance instructions.

270 MIRRORS WHERE INDICATED

- Dimensions:
  - Length: as indicated.
  - Width: as indicated.
  - Thickness: as indicated.
- Material: Silvered float glass to BS EN 1036-1.
- Quality: Free from tarnishing, discoloration, scratches and other defects visible in the designed viewing conditions. Reflection undistorted.
- Backing: Polypropylene safety film.
- Edges:
  - Treatment: Polished.
  - Profile: Bevelled, 12 mm.
- Fixing: Holes, 4 mm diameter, inset 50 x 50 mm from corners, for fixing screws.
- Installation: Accurately with sides vertical.

275 FRAMED MIRRORS WHERE INDICATED

- Overall dimensions:
  - Length: as indicated.
  - Width: as indicated.
  - Thickness: as indicated.
- Mirror:
  - Material: Silvered float glass to BS EN 1036-1.
- Quality: Free from tarnishing, discoloration, scratches and other defects visible in the designed viewing conditions. Reflection undistorted.
- Backing: Polypropylene safety film.
- Frame:
  - Material: Aluminium.
  - Finish/ Colour: Satin anodized, silver.

300 ENTRANCE MATTING TO FRONT ENTRANCE AND WHERE INDICATED

- Manufacturer: Submit proposals To Engineer's approval.
  - Product reference: Submit proposals To Engineer's approval.
- Arrangement: Inset external or loose laid as indicated.
- Material: Heavy-duty recycled rubber open ring matting.

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- Type: Modular interlocking units with open structure for drainage.
- Pattern: Ribbed.
- Colour: as selected by Engineer from manufacturer's standard range.
- Size: as indicated on drawings to fit matwell.
- Installation: Loose-laid or recessed within matwell as indicated.
- Integral accessories: Extruded Aluminium matwell frame where recessed.

350 MISCELLANEOUS FITTINGS

- Item: Grab rails.
- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Size/ Capacity: as indicated.
- Material: stainless steel 1.4401 Class A4.
- Finish/ Colour: satin no. 4.
- Fixing: as indicated.
- Other requirements: none.

460 SEALANTS TO WORKTOPS

- Standard: To BS EN ISO 11600, class F20 HM.
- Type: One part silicone.
  - Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
  - Cure: Neutral.
- Colour: Clear
- Other requirements: Fungicidal.

EXECUTION

710 MOISTURE CONTENT OF WOOD AND WOOD-BASED BOARDS

- Standard: To BS EN 942
- Moisture content on delivery: 12-16%
- Temperature and humidity: During delivery, storage, fixing and to handover maintain conditions to suit specified moisture contents of timber components.

720 INSTALLATION GENERALLY

- General: As Preliminaries.
- Fixing and fasteners: As section Z20.
- Services: As Engineering Services specification.

760 SEALANT BEDDING AND POINTING

- Application: As section Z22.
- Bedding: Sinks to top of worktops.
- Pointing: Joints between worktop and splash backs.

770 TRIMS

- Lengths: Wherever possible, unjointed between angles or ends of runs.
- Running joints: Where unavoidable, obtain approval of location and method of jointing.
- Angle joints: Mitred.

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COMPLETION

910 GENERAL

- Doors and drawers: Accurately aligned, not binding. Adjusted to ensure smooth operation.
- Ironmongery: Checked, adjusted and lubricated to ensure correct functioning.

920 APPLIANCES

- Test: Ensure that all functions and features work correctly.
- Documentation: Submit guarantees, instruction manuals, etc.

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N13A - SANITARY APPLIANCES AND FITTINGS

To be read in parallel with section N13B (Architecture)

PART 3 SPECIFICATION CLAUSES SPECIFIC TO N13

300.000 GENERAL

300.010 SANITARY FITTING INSTALLATION:

- Supply, install, commission and set to work sanitary fitting installation in accordance with
- Standard
    - Comply with the services aspects of the code of practice for the design of sanitary facilities BS 6465-1.
    - On design and build projects comply with the space recommendations in BS 6465-2.
    - Select and install sanitary and associated appliances in accordance with BS 6465-3.
    - BS EN 806-4 and complimentary guidance in BS 8558
    - BS 8300-1.
    - BS 8300-2.
    - BS EN 12056-2.

300.030 SANITARY INSTALLATIONS FOR THE DISABLED:

- Ensure sanitary installations for the disabled are installed in accordance with BS 8300-1 and BS 8300-2.

300.040 SHOWER UNITS:

- Ensure shower unit installations are installed in accordance with BS EN 251 and BS 6340.

300.070 FINISHES:

- Ensure the finishes of all sanitary fittings comply with the interior architectural selections.

310.000 PRODUCTS/MATERIALS

310.010 W.C. PANS:

- Style
- As specified in the sanitary manual.
    - Arrangement
        - Vitreous china Wall hung to BS EN 33.

            BS EN 33 with independent water supply.
    - Method of operation
        - As per sanitary manual
    - Material
        - Vitreous china to BS 3402.

- Accessories
    - Flush pipe.
    - Flexible connector to BS 5627.
    - Connector.
- Characteristics
    - Finish and colour : subjected to engineer approval

- Seat
    - Type
        - BS 1254.
    - As per sanitary manual Seat and cover material
        - As per sanitary manual and subjected to engineer approval
    - Accessories
        - Seat pillars and hinges to BS 1254.
            - Protective washer between hinge fixings and both sides of the ceramic ware.
        - [Flush valve
        - Hand shower spray
    - Characteristics
        - Finish and colour: As per sanitary manual and subjected to engineer approval

310.040 SINKS:

- Style
- As per sanitary manual and subjected to engineer approval
- Arrangement
    - Floor mounted.
    - Wall-mounted.
    - Incorporated in fitment
    - As per sanitary manual and subjected to engineer approval
- Material
    - Stainless steel.
- Tap holes
- As per sanitary manual and subjected to engineer approval
- Characteristics
    - Finish and colour
    - As per sanitary manual and subjected to engineer approval

- Accessories
    - Support brackets.
    - Bucket grating.

- Standing tube overflow.
- Drainer.
- Faucet Mixer

310.050 WASH BASINS:

- Standard
  - [Ceramic wash basin and pedestal to BS 1188.]
  - As per sanitary manual and subjected to engineer approval
  - Material
    - Vitreous china to BS 3402.
  - Wall hung hand rinse basins to BS EN 111.
    - Type
      - As per sanitary manual and subjected to engineer approval
- Characteristics
  - Finish and colour : As per sanitary manual and subjected to engineer approval
- Accessories
  - Support brackets.
  - Faucet Mixer

310.090 SHOWER UNITS:

- Duty
  - Supply showers with nominal flow rate no greater than 9 litres per minute. Accomplish low flow rates using aerating/flow restrictor devices.
- Style
  - chrome plated bath mixer
  - 20 mm shower outlet, integrated non-return valve, with handles and fastening set
  - Shower hose 1700mm
  - chrome plated basket sponge /soap holder
  - chrome plated robe hook.
  - And as specified in the sanitary manual and subject to Engineer's approval.
- Shower controls
  - Combined flow and temperature control.

310.180 HOSE BIBB:

to consist of chrome plated metal bibcock, 15 mm male back inlet connection and 15 mm male, hose thread outlet, with 15 mm chrome plated metal hose union female threaded similar to kohler or approved equal. and as specified in the sanitary manual:

- HB-1: As per sanitary manual and subject to Engineer's approval.

310.230 WASTE FITTINGS:

- Appliance
  - Sink
  - Wash basin
- Standard
  - BS EN 274-1, BS EN 274-2, BS EN 274-3
- Type
  - Plug.
  - Plug, pop up
  - Grated.
  - Standing.
  - Strainer.
  - Overflow
- Accessories.
  - Plug and chain fixed
  - Coupling nuts.

310.240 TRAPS:

- Appliance
  - WC. pan
  - Sink
  - Wash basin
  - Shower unit
- Type
  - Integral with appliance.
  - Tubular.
- Form
  - [P.]

310.250 TAPS:

- Appliance
  - Sink
  - Wash basin
- Arrangement
  - On appliance
  - On wall or panel above appliance
- Standard
  - Performance of draw-off taps

- Spray taps to BS 5388.
- Spray mixing taps to BS 5779.
- Single and mixer taps to BS EN 200.
- Flow rate regulators to BS EN 246.
- Electrodeposited nickel chrome coatings to BS EN 248.

- Type
  - As per sanitary manual
- Characteristics
  - Thermostatic mixing valves to BS EN 1111 operating at dynamic pressure (1-5bar)
  - Mixing valves Finish and colour: as per sanitary manual

320.000 WORKMANSHIP

320.010 GENERAL:

- Carry out work in accordance with BS EN 12056-2.
- On delivery check that all components are in accordance with the requirements and are free from defects and damage. Reject any incorrect, defective or damaged items.
- Obtain all appliances and components from the same manufacturer.
- Store delivered components in secure weatherproof accommodation, as recommended by the manufacturer. Ensure that the storage method does not cause damage to the components.

320.020 INSTALLATION OF APPLIANCES:

- Assemble, install and fix the appliance so that services designed to falls will drain as intended, and as recommended by the manufacturer.
- Joint and bed all components using compounds and methods recommended by the manufacturer.
- Do not use or allow use of sanitary installation until directed.

320.030 INSPECTION AND CLEANING:

- After installation, inspect all appliances and components and reject and replace any defective or damaged items. Protect appliances until handover. Clean all sanitary appliances and installations:
  - On contract completion.
  - Before they are taken into use.

320.040 WORKS ON-SITE:

- Ensure that all building works and service connections are carried out in accordance with the requirements, before fixing the appliances

320.050 SHOWER UNITS:

- Install shower units in accordance with BS EN 251 and BS 6340.

320.070 INSTALLATION OF CISTERNS:

- Obtain all cistern operating components from the cistern manufacturer.
- Ensure that ball valve matches water supply head.
- Install cisterns in accordance with the manufacturer's recommendations.

320.075 WC PANS PIPE CONNECTIONS:

- Plastic
    - Connect all soil pipe spigots with plastic connectors in accordance with manufacturer's recommendations.

320.080 SEALANT:

- Seal between floor and wall and appliance with sealant with fungicide.
- Ensure colour of sealant,
    - Matches sanitary fittings.
    - complies with schedule of sanitary fittings and finishes
- Procedure
    - Check that joints are suitable and joint dimensions are within the limits indicated for the sealant by its manufacturer.
    - Clean surfaces to which sealant must adhere using methods and materials recommended by the sealant manufacturer.
    - Before applying primer and sealant, cover adjacent surfaces difficult to clean with masking tape.
    - Use backing strips, bond breaker and primer recommended for the purposes by the sealant manufacturer.
    - Use equipment and methods recommended by the sealant manufacturer.
    - Use the sealant within the application life of primer and sealant and within the air and surface temperature ranges recommended by the sealant manufacturer. Do not apply primer or sealant to damp surfaces.
    - Do not heat or raise the temperature of sealed joints to speed drying.
    - Fill joints completely, leaving no gaps, exclude all air and ensure firm adhesion of sealant to required joint surfaces.
    - Tool the sealant to a neat slightly concave profile unless otherwise indicated.
    - Protect the sealed joints until cured.

320.090 FIXING:

- Use only fixing and jointing methods, types, sizes, quantities and spacings which are suitable for,
    - Nature and compatibility of materials.
    - Recommendation of manufacturers of both fixing materials and sanitary components.
    - Components and loads to be supported.
    - Conditions of expected use.
    - Appearance.
- Floor mounted appliances
    - Ensure all floor mounted appliances are made to a secure base in an even manner.

- Material of fixings
    - Use only non-ferrous or stainless steel.
- Fixing through finishes
    - Ensure that fastening and plugs amply penetrate into the backing.
- Brackets
    - Use low carbon steel brackets or other supports only if they are galvanized to BS EN ISO 1461.
- Chases and ducts
    - Ensure all holes, chases and ducts required have been provided.
- Noggins and bearers
    - Ensure noggins and bearers fixings are accurately positioned and securely fixed.
- Tiled backgrounds
    - Ensure tiled backgrounds are complete before fixing appliances and that fixings do not overstress the tiles.
- Overflow pipes
    - Ensure overflow pipes are fixed to provide a fall to outlet.
    - Ensure overflow pipes are positioned as required.
- Taps
    - Fix taps securely with watertight seals.
    - Place hot tap on left of cold tap as viewed by user of appliance.
- Wastes
    - Bed wastes in waterproof jointing compound and fix with resilient washer between appliance and backnut.

N13B SANITARY APPLIANCES AND FITTINGS

To be read with Preliminaries/ General Conditions.

PRODUCTS

425 SANITARY ACCESSORIES GENERALLY

- Refer to the Sanitary Fixtures Manual
- Manufacturer: Submit proposals to Engineer's approval.
- Product reference: Submit proposals to Engineer's approval.

429 HOOKS GENERALLY

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Material: stainless steel 1.4401 316.
- Finish/ Colour: satin unless otherwise indicated on drawings.

436 GRAB BARS GENERALLY

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Diameter: 35 mm.
- Material: stainless steel 1.4401 grade 316.
- Finish/ Colour: satin unless otherwise indicated.
- Texture: As indicated in finish manuals.
- Dimension: As indicated in manuals.

438A TILT MIRRORS

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Material: stainless steel 1.4401 grade 316.
- Frame: stainless steel.
- Finish/ Colour: satin finish unless otherwise indicated.

438B MIRRORS

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Type: Wall-mounted mirror with aluminium frame and LED lighting.
- Mirror:
  - Clear mirror glass with safety backing.
  - Thickness: As indicated.
- Frame Material: Aluminium.
  - Finish/ Colour: satin finish unless otherwise indicated.

441 PAPER ROLL DISPENSERS

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Material: stainless steel 1.4401 grade 316.
  - Width: as shown on drawings and in sanitary manual.
  - Finish/ Colour : as shown in manual.

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441A PAPER ROLL DISPENSERS

Manufacturer: Submit proposals to Engineer's approval.

- Product reference: Submit proposals to Engineer's approval.
  Material: stainless steel 1.4401 grade 316.
  Finish/ Colour: satin finish unless otherwise indicated in the sanitary manual.

442 PAPER TOWEL DISPENSERS

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Material: stainless steel 1.4401 grade 316.
- Finish/ Colour: as shown in manual.

446 SANITARY TOWEL DISPOSAL BINS GENERALLY

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Material: stainless steel 1.4401 grade 316.
- Finish/ Colour: as shown in manual.

458 SOAP DISPENSERS GENERALLY

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Material: stainless steel 1.4401 grade 316.
- Finish: as shown in manual.
- Mounting Type: Wall Mounted
- Dimension: As indicated in manuals.
- Operation: Electrically operated.
- Dispense Type: Foam Soap, Foam Sanitizer.
- Capacity: 800ml.

460 HAND DRYER

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Type: Wall-mounted hand dryer.
- Operation: Electrically operated, automatic sensor type.
- Material: stainless steel 1.4401 grade 316.
- Finish/ Colour: Satin-Finish, unless otherwise indicated.
- Dimension: As indicated in manuals.

462 TOILET PAPER HOLDERS GENERALLY

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Material/ finish: stainless steel 1.4401 grade 316.
- Finish/ Colour: as shown in manual.

462B DOUBLE TOILET ROLL HOLDERS

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Material/ finish: stainless steel 1.4401 grade 316.
- Finish/ Colour: Satin-Finish, unless otherwise indicated.
- Dimension: As indicated in manuals.
- Mounting Options: Wall mount.

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474 AWASTE BINS GENERALLY

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Material: stainless steel 1.4401 grade 316.
- Finish/ Colour: as shown in manual.

474B UNDER COUNTER WASTE BIN

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Type: Under counter waste bin.
- Material: As indicated.
- Finish / Colour: As indicated in finishes manual.
- Capacity: As per manufacturer's standard.
- Operation: Pull-out type.
- Dimensions: As indicated on drawings.

475 BABY CHANGING STATION

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Type: Wall-mounted.
- Material:
  - High-density polyethylene (HDPE).
- Finish / Colour: As indicated in finishes manual.
- Operation: Fold-down type.
- Features:
  - Safety strap.
  - Smooth, easy to clean surface.
- Load capacity: As per manufacturer's standard.
- Dimensions: As indicated on drawings.

476 DIAPER VENDOR

- Manufacturer: Submit proposals to Engineer's approval.
- Product reference: Submit proposals to Engineer's approval.
- Type: Wall-mounted.
- Material: Powder coated steel.
- Finish / Colour: As indicated in finishes manual.
- Operation: As indicated.
- Capacity: As per manufacturer's standard.
- Dimensions: As indicated on drawings.

477 SANITARY NAPKIN DISPOSAL UNIT

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Type: Wall-mounted sanitary napkin disposal unit.
- Mounting: Surface mounted unless otherwise indicated on drawings.
- Material: As indicated.
- Finish / Colour: As indicated in finishes manual.
- Operation: Self-closing lid.
- Receptacle: Removable internal container.
- Dimensions: As indicated on drawings.

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478 WALL-MOUNTED NAPKIN / TAMPON VENDOR

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Type: Wall-mounted napkin / tampon vending unit.
- Mounting: Surface mounted.
- Material: As indicated.
- Finish / Colour: As indicated.
- Operation: Coin operated or free issue.
- Capacity: As per manufacturer's standard.
- Lock: Key operated lock.
- Dimensions: As indicated on drawings.

EXECUTION

610 INSTALLATION GENERALLY

- Assembly and fixing: Surfaces designed to falls to drain as intended.
- Fasteners: Nonferrous or stainless steel.
- Supply and discharge pipework: Fix before appliances.
- Fixing: Fix appliances securely to structure. Do not support on pipework.
- Jointing and bedding compounds: Recommended by manufacturers of appliances, accessories and pipes being jointed or bedded.
- Appliances: Do not use. Do not stand on appliances.
- On completion: Components and accessories working correctly with no leaks.
- Labels and stickers: Remove.

613 COMPATIBILITY OF COMPONENTS

- General: Each sanitary assembly must consist of functionally compatible components, preferably obtained from a single manufacturer.
  - Exceptions: Wastes and traps.

755 SEALANT BEDDING AND POINTING

- Bedding: Bed and point basins to underside of vanity units.
- Pointing: Joints between appliances and splashbacks.

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N14 GENERAL INTERNAL SIGNAGE SYSTEMS

To be read with Preliminaries/ General Conditions.

GENERAL

110 SIGNAGE SYSTEM GENERALLY

- System manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Layout and dimensions: As indicated in signage manual.
- Lettering:
  - Language: English and as indicated in the signage manual.
  - Font: Manufacturer's standard range as indicated in the signage manual.
  - Colour: Manufacturer's standard range as indicated in the signage manual.
  - Size: Manufacturer's standard range as indicated in the signage manual.
- Symbols and graphics: Manufacturer's standard range as indicated in the signage manual.
  - Colour: Manufacturer's standard range as indicated in the signage manual.
  - Size: Manufacturer's standard range as indicated in the signage manual.
- Background colour: Manufacturer's standard range as indicated in the signage manual.
- Sign type:
  - Aluminium letters;
  - Aluminium plate;
  - Plastics letters;
  - Plastics sheet;
  - UV printed letters;
  - Stove enamelled plate; and
- Submit proposals as indicated in the signage manual for Engineer's approval.
  - Inserts: Composite metal and plastics and as indicated in the signage manual.
  - Manufacturing process: Manufacturer's standard and as indicated in the signage manual.
- Supports/ Fixings: Submit proposals as indicated in the signage manual to Engineer's approval.
- Accessories: Not required.

120 POST AND MULTI-POST SIGNS GENERALLY

- Manufacturer: Submit proposals to Engineer’s approval.
  - Product reference: Submit proposals to Engineer’s approval.
  - Type: Freestanding post or multi-post signage system.
- Configuration:
  - Sign panels mounted between one or more vertical posts.
  - Panels to be of box or flat panel construction, as indicated in signage manual.
  - Provide smooth, uniform surfaces with clean edges and sharp profiles.
- Sign panels:
  - Material: Aluminium Composite Panel, as indicated in signage manual.
  - Thickness: As indicated in signage manual.
  - Size / layout: As indicated on drawings and signage manual.
  - Finish / colour: As indicated in signage manual.
  - Graphics: Translucent Vinyl cut out letters, arrows and pictograms or integral illuminated finish as indicated.
- Illumination (where applicable):
  - Internal or edge-lit LED system, as indicated.

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  - Provide complete system including drivers, wiring, and accessories.
  - Ensure uniform illumination without light leakage.
  - Power supply as indicated on drawings.
- Frames (where applicable):
  - Material: As indicated (typically aluminium).
  - Profile / depth: As indicated in drawings and signage manual.
  - Corners: Radiused unless otherwise indicated.
  - Finish / colour: As indicated in signage manual.
  - Provide access panels for maintenance where required.
- Posts:
  - Material: As indicated.
  - Shape / size: As indicated in signage manual.
  - Finish / colour: As indicated in signage manual.
  - Arrangement: Single or multiple posts as indicated.
- Fixing / installation:
  - Method: Baseplate fixed to foundation or as indicated.
  - Install plumb, level, and securely fixed.
  - Coordinate with structural and civil works.
- Performance:
  - Complete system to BS 559.
- Text and graphics: Typeface, size, colour, and layout as indicated in drawings and signage manual.

120 INTERNALLY ILLUMINATED PYLON SIGNS GENERALLY

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Type: Freestanding internally illuminated pylon signage system.
- Configuration:
  - Sign panels integrated within vertical pylon structure.
  - Panels to be of box-type construction, as indicated in signage manual.
  - Provide smooth, uniform surfaces with clean edges and sharp profiles.
- Sign panels:
  - Material: Aluminium Composite Panel, as indicated in signage manual.
  - Thickness: As indicated in signage manual.
  - Size / layout: As indicated on drawings and signage manual.
  - Finish / colour: As indicated in signage manual.
  - Graphics: Translucent Vinyl cut out letters, arrows and pictograms or integral illuminated finish as indicated.
- Illumination:
  - Internally illuminated LED system.
  - Provide complete system including drivers, wiring, transformers, and accessories.
  - Ensure uniform illumination without light leakage or hotspots.
  - Power supply as indicated on drawings.
- Frames / Pylon structure:
  - Material: As indicated (typically aluminium or metal).
  - Profile / depth: As indicated in drawings and signage manual.
  - Corners: Radiused unless otherwise indicated.
  - Finish / colour: As indicated in signage manual.
  - Provide access panels for maintenance and replacement of internal components.
- Support structure:

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  - Integrated structural pylon with internal framing.
  - Shape / size: As indicated in signage manual.
  - Finish / colour: As indicated in signage manual.
- Fixing / installation:
  - Method: Baseplate fixed to foundation or as indicated.
  - Install plumb, level, and securely fixed.
  - Coordinate with structural, electrical, and civil works.
- Performance:
  - Complete system to BS 559.
- Text and graphics:
  - Typeface, size, colour, and layout as indicated in drawings and signage manual.

SYSTEM PERFORMANCE

210 GENERAL REQUIREMENTS

- Signage system: Complete to BS 559, including facing information, components, inserts, accessories and fixings necessary to complete the system.
  - Comply with the requirements of:
  - Fire strategy report;
  - Building operation report; and
- Wayfinding strategy.
- Geometric shapes, colours and layout: In accordance with BS 8501.
- Design standard for disabled people: In accordance with BS 8300.
- Proposals: Submit drawings, schedules, technical information, calculations and manufacturer's literature.

240 FIRE REACTION OF SIGNAGE SYSTEM

- Non-flammable surface:
  - Standard: Class 1 to BS 476-7.

280 DESIGN LIFE OF SIGNAGE SYSTEM

- Duration: 10 years.
  - Subject to reasonable wear and tear.
- Condition of use: Subject to regular maintenance.

290 SIGNAGE SAMPLES

- Sign type: to the specified Signage system.
  - Action: Submit labelled samples.
  - Conformity: Retain samples on site for the duration of the contract or until instructed to remove.
  - Delivered product: To conform with labelled samples.

295 SIGNAGE SAMPLES BOARD

- Samples board: Submit.
  - Content: Selected labelled signs, showing methods of fixing.
  - Conformity: Retain samples on site for the duration of the contract or until instructed to remove.
  - Delivered product: To conform with labelled samples.

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PRODUCTS

305 PRODUCTS GENERALLY

- Standard: To BS 559.

310 ADHESIVE VINYL GENERALLY

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Component thickness: 2 mm.
- Finish: Matt or gloss as indicated on drawings.

320 ALUMINIUM GENERALLY

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Component thickness: 6 mm, 2 mm facing on 4 mm backing panel unless otherwise indicated on drawings.
- Finish: Powder coated to BS 6496 unless otherwise indicated on drawings.
- Perimeters: Radiused corners unless otherwise shown on drawings.

350 PLASTICS GENERALLY

- Material: Acrylic.
- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Component thickness: 6 mm, 2 mm facing on 4 mm backing panel unless otherwise shown on drawings.
- Finish: Manufacturer's standard unless otherwise shown on drawings.
- Perimeters: Radiused corners unless otherwise shown on drawings.

370 STOVE ENAMELLED METAL PLATE GENERALLY

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Base material: Mild steel.
- Component thickness: 2 mm unless otherwise shown on drawings.
- Finish: Manufacturer's standard.
- Perimeters: Radiused corners unless otherwise shown on drawings.

EXECUTION

610 FIXING SIGNS GENERALLY

- Installation: To BS 559.
  - Secure, plumb and level.
- Strength of fasteners: Sufficient to support all live and dead loads.
- Fasteners and or adhesives: As section Z20.
- Fixings showing on surface of sign: Must not detract from the message being displayed.

620 FIXING SIGNS FOR THE VISUALLY IMPAIRED

- Protection of users:
  - Fasteners for tactile/ Braille signs must not have sharp edges or protrusions that would cause confusion or injury to users.

670 ELECTRICAL AND DATA SERVICES

- Services connection required: Power for lighting.

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- Standard: To BS 7671.
- Coordinate with services trades.

COMPLETION

910 DOCUMENTATION

- Submit:
  - Manufacturer's maintenance instructions.
  - Guarantees, warranties, test certificates, record schedules and log books.

920 SPARES

- Supply as follows:
  - Type: Signage systems specified.
  - Quantity: 5 modular sets containing all alpha and numeral characters and as directed by Engineer.

930 SPECIALIST TOOLS

- Supply as follows: 2 sets of nameplate adjustment tools.

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N20B - SPECIAL PURPOSE FIXTURES, FURNISHINGS AND EQUIPMENT – MECHANICAL

To be read in parallel with section N20A (Architecture)

PART 3 SPECIFICATION CLAUSES SPECIFIC TO N20B

300.000 PRODUCTS/MATERIALS

300.010 EQUIPMENT: LONG SPAN HEAVY DUTY SHELVES

Industrial shelving having the following features/components:

- Open type steel shelves, utilizing sway braces for stability of shelving unit.
- Ready to assemble. Boltless upright system
- Solid coated steel construction.
- Shall be used for the storage of non-palletized items such as boxes and smaller items.
- Dimensions of shelving unit: as per design drawings
- Shelving unit shall have shelves, and can be considered as a starter unit. Adder units shall be connected to it to create rows of shelving.
- Shelving units can be placed back to back, creating a double-faced shelving arrangement.
- These units shall be complete and freestanding.
- Capacity: 400 Kg/shelf, assuming evenly distributed loads on shelf.
- Shall be easily adjustable to fit specific needs.
- Shall utilize box beam shelves for high capacity and angle posts on all sides for easy shelf adjustment and assembly.
- Coating of steel shelves shall be factory applied, and according to manufacturer's standard.

300.020 HEAVY DUTY RACKS

These are coated steel racks made from hot dip galvanized steel used for storage; providing the most selectivity and flexibility, and having but not limited to the following features:

- Uprights, braces and beams constructed of high tensile steel.
- Steel Quality: Rolled steel for general structure (SS400, SS540)
- Type Steel plate in mother coil form
- Standard Number Class 2 (SS400), Class 3 (SS490)
- Grade SS400, SS540
- Tensile strength (min.) 400N/mm² (SS400), 540 N/mm² (SS540)
- Yield Strength (min.) 305 N/mm² (SS400), 450 N/mm² (SS540)

Rack End frames:

- Upright width 100mm
- Upright thickness 2.6mm
- Upright finish (painted / galvanized) galvanized
- Tensile strength (min.) 540 N/mm² (SS540)
- Shape of bracing section lipped channel (C shape)
- Dimension of bracing section 40x22mm (100post)
- Bracing section thickness 1.2mm
- Bracing colour finish (painted / galvanized) galvanized

Rack Longitudinal Beams:

- Dimension of beam std Box-beam 105/50/1.5 and 125/50/1.5
- Interlocking 'C' section formed from two interlocking 'C' section
- Tensile strength (min.) 400 N/mm² (SS400)
- Beam colour finish (painted) orange (RAL 2004)
- Paint finish (lead-free / normal) epoxy-polyester powder coating (lead-free)

- A lower beam is required for pallets positioned on floor.
- Rack dimensions: 1050x2900x1500 mm
- Ready to assemble, solid steel construction.
- Standard deflection shall be a maximum of 1/200 of the beam length.
- Beam Capacity:4000 Kg/pair of beam/level
- Beams to have special safety lock preventing the accidental beam removal.
- Racks can be placed back-to-back, creating a double-deep rack arrangement.
- Racks shall be used in standard aisle configuration and very narrow aisles.
- Coating of steel racks shall be factory applied, and according to manufacturer's standard.
- Ram rack column protection to be provided.
- Crash Barriers used to protect the exposed upright frames at the end of each aisle by forklift collusion.
- Mesh decking on the top of the beam on each level and section of the pallet racking storage. Mesh decking shall be 6mm diameter with reinforcing bar support.
- Provision for storage items identification system (barcode or labeling) to be provided.

310.000 WORKMANSHIP

310.010 INSTALLATION:

- Install and test equipment in accordance with manufacturer's recommendations.

N25 PERMANENT ACCESS AND SAFETY EQUIPMENT

To be read with Preliminaries/ General Conditions.

TYPES OF SYSTEM/ EQUIPMENT

110 PERMANENT SUSPENDED ACCESS SYSTEM GENERALLY

- Type: Telescopic crane on anchored track.
- Design/ Manufacture/ Installation: Generally to BS EN 1808 and in accordance with BS 6037-1.
- Manufacturer: Submit proposals to Engineer's approval.
  - System reference: Submit proposals to Engineer's approval.
- Position and dimensions: As drawings.
- Mode of operation: Electrically powered.
  - Power supply: 3 pH, 400 V, 50 Hz, neutral earth unless otherwise indicated.
- Cradle: To BS EN 1808 and in accordance with BS 6037-1.
  - Maximum vertical travel distance: as indicated.
  - Carrying capacity (persons): two persons unless otherwise indicated.
  - Rated load: as indicated.
  - Clear working width: as indicated.
  - Length: as indicated.
  - Material: Galvanized steel with polyurethane system protective coating.
  - Infill between guardrails: Galvanized steel Solid sheet with polyurethane system protective coating.
  - Attachment points: Provide at least one safety harness attachment point per person. Provide additional points for attaching platform restraint system, where fitted.
  - Lateral restraint system: As clause 115.
  - Fenders: Provide suitable protective cushions/ rollers to prevent cradle from damaging building.
- Finishes: polyurethane coating system as recommended by manufacturer to meet corrosive environment indicated in accordance with ISO 12944.
- Connection to building superstructure: as indicated on drawings.
- Other requirements: as indicated.

115 LATERAL RESTRAINT SYSTEM FOR SUSPENDED CRADLE

- System: Stabilization of cradle against lateral movement at all working locations to be provided by: suspension rope restraint.
- Vertical spacing of restraint system attachment points: Not more than 16 m, including the first drop from the jib.

140 TRAVELLING LADDER GENERALLY

- Type: Standard.
- Manufacturer: Submit proposals to Engineer's approval.
  - Reference: Submit proposals to Engineer's approval.
- Position and dimensions: As drawings.
- Mode of operation: Manual (push/ pull).
  - Power supply: Not required.
- Height, excluding any extension units: as drawings.
- Carrying capacity (persons): two persons unless otherwise indicated.
- Material: galvanized steel with polyurethane protective coating system.
  - Finish: polyurethane protective coating system.

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- Tracks:
  - Upper: Roof mounted.
  - Lower: Integrated into façade.
- Working platform: Single sliding folding.
- Ancillary equipment: Telescopic extension unit with winch unless otherwise indicated.
- Connection to building superstructure: as drawings.

210A GUIDED TYPE FALL ARREST SYSTEM Portable Davit System

- Manufacturer: Submit proposals to Engineer's approval.
  - System reference: Submit proposals to Engineer's approval.
- Anchorage device: Vertical/ Horizontal aluminium rail with turntable.
- Overall system length: as drawings.
- Intermediate support spacing: as drawings.
- Accessories/ Other requirements: Fall arrest (EN 795: 2012) and personnel winching.
- Installation: In accordance with BS 7883 by the system manufacturer or a contractor approved by the system manufacturer.
- Structural anchors: Type recommended by the system manufacturer to suit the structure/ fabric into which they will be fixed.

220 SINGLE POINT ANCHORAGE DEVICES FOR CRADDLE RESTRAINT

- Standard: To BS EN 795.
- Type: flush mounted sockets.
- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Material/ Finish: stainless steel 1.4401 grade 316.
- Locations: as drawings.
- Installation: In accordance with BS 7883.
- Other requirements: Provide with each anchor:
  - A backing disc giving the manufacturer's name and telephone number and the date of installation.
  - A certificate of compliance with testing and examination requirements of BS EN 365.

DESIGN/ PERFORMANCE REQUIREMENTS

415A WIND LOADING TO BS EN 1991-1-4

- General: Design access/ safety system to withstand calculated wind loads with equipment in position of maximum exposure and in parked position.
- Design wind pressure: Calculate to BS EN 1991-1-4.
  - Wind loads shall be calculated according to BS EN 1991-1-4: 2005
  - Basic wind velocity is equal to 30 m/s 10 minute mean wind velocity with an annual risk of being exceeded of 0,02 which is equal to a mean return period 50 years. At a height of 10 m above flat open country terrain.
  - Terrain Category: II
  - Structural Factor, CsCd = 1.0

430 SAFETY

- General: The equipment as installed must have no irregularities/ projections capable of inflicting personal injury.
- Finished surfaces and edges of all accessible parts: Regular and smooth.

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440 DESIGN LIFE/ MAINTENANCE PROGRAMME

- Design life of access/ safety system: Not less than 50 years.
- Schedule for maintenance and for replacement of components: Submit.

450 TESTING OF PERMANENT SUSPENDED ACCESS EQUIPMENT

- Pre-installation testing: Test roof rig at manufacturer's/ supplier's works. The rig must be capable of lifting and sustaining a proof load of 125% of the specified rated load without suffering damage or permanent deformation.
- Post-installation testing: Immediately on completion of installation, or when otherwise agreed, examine and test the complete installation in accordance with recommendations given in BS 6037-1, clause 14. Give adequate notice of testing arrangements.
- Certificates for works and site testing: Submit within 7 days of completion of satisfactory acceptance tests.

460 ASSESSMENT/ TESTING OF ANCHOR DEVICES

- Design and testing of anchors: To BS EN 795.

FABRICATION, ASSEMBLY AND INSTALLATION

510 FABRICATION AND ASSEMBLY GENERALLY

- Machine cutting, drilling and assembly: Carry out as much as possible in the workshop. Obtain approval for any reassembly on site.
- Dissimilar metal surfaces of assembly components/ supports/ fixings: Isolate to prevent electrolytic corrosion.

520 PROTECTION

- General: Do not deliver to site any components or assemblies that cannot be installed immediately or unloaded into a suitable well protected storage area.

530 SUITABILITY OF STRUCTURE/ FABRIC

- Visual and geometric survey of supporting structure and fabric: Carry out before commencing installation of access/ safety system. Report immediately if structure/ fabric will not allow required accuracy/ security of erection/ fixing.

535 EXECUTION GENERALLY

- Structural members: Do not modify, cut notch or make holes in structural members without permission.
- Frameworks: Assemble and brace, including temporary members required for installation.
  - Temporary support: Do not use access systems as temporary support or strutting for other work.
- Bolted joints:
  - Contact between dissimilar metals: Avoid.
  - Bolts and washers: Select types, sizes and quantities of fasteners or packings and spacings to retain supported components without distortion or loss of support.
- Welded joints: Comply with latest edition of National Structural Steelwork Specification (NSSS), Section 5.
- Finished components: Smooth, free from distortion, cracks, burrs and sharp arrises.

540 MECHANICAL FIXINGS

- Materials: Unless otherwise recommended by equipment manufacturer:
  - Connecting bolts and other fixings fully accessible for inspection: Carbon steel hot dip galvanized to BS 7371-6.

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- Nuts: Tapped after galvanizing.
  - Cast-in anchors and other fixings not accessible for routine inspection: Austenitic stainless steel, grade 1.4401 (316) to BS EN 10088-1.

550 FASTENERS, INSERTS AND BOLTS FOR BUILDING IN

- Supplier: Equipment manufacturer/ supplier.

560 FIXINGS FOR SECURING EQUIPMENT

- Adjustment capability: Adequate three dimensional adjustment to accommodate building structure/ fabric irregularities.

570 FIXING ANCHOR INSTALLATION

- Site drilling or cutting into structure/ fabric: Permitted only in approved locations.
- Distance between all fixing devices and edges of supporting material: Not less than recommended by fixing manufacturer.

605 IDENTIFICATION AND REGISTRATION LABELS FOR SUSPENDED ACCESS SYSTEM

- Provision:
  - Suspension rig and any non-dedicated track systems: Provide and fix a permanent label giving:
    a) Manufacturer's name, address and telephone number.
    b) Name and/ or reference code of model.
    c) Serial number and year of manufacture.
    d) Rated load of suspended platform (where the platform is permanently attached to the system) or maximum total suspended load (where the platform can be derigged).
  - Suspended platform: As a), b) and c) above, plus
    d) Rated load and self-weight in kg of the platform.
    e) Maximum number of persons allowed on the platform.
    f) Identification mark or number of the suspension rig or rigs with which the platform is compatible (where the platform can be derigged).
  - Suspension and safety ropes (detachable): Marked with length and unique identification number.
- Location: In positions such that labels can be easily read.

610 IDENTIFICATION AND REGISTRATION LABELS FOR OTHER EQUIPMENT FOR BUILDING MAINTENANCE SYSTEM

- Provision: Provide and fix to each piece of equipment a permanent label giving:
  - Manufacturer's name, address and telephone number.
  - Name and/ or reference code of model.
  - Serial number and year of manufacture.
  - Maximum load (in kilograms) that may be sustained by the equipment.
- Location: In positions such that labels can be easily read.

615 CE MARKING AND DECLARATION OF CONFORMITY OF PERMANENTLY INSTALLED SUSPENDED ACCESS EQUIPMENT

- Marking: Equipment to be clearly labelled with a CE mark indicating conformity with the current edition of the Supply of Machinery (Safety) Regulations.
- Declaration of conformity: Provide for the complete installation a declaration of conformity with Machinery Directive 2006/42/EC together with certificates of incorporation for parts not supplied or installed by the main equipment manufacturer or supplier.

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630 LIFTING EQUIPMENT CONFIGURATION

- General: Where the rated load of machinery for lifting depends on its configuration, the identification and registration labels and rated load notices must indicate the rated load for each configuration.

640 MARKING OF ANCHOR DEVICES

- Provision: Provide on or near each anchor device a label or other clear marking giving:
  - Manufacturer's name and telephone number.
  - Serial number and year of manufacture of device.
  - Maximum number of personnel that may be attached to the device at any one time.
  - Requirements for energy absorbers, ground clearance, etc.
- Anchor devices intended solely for use with personal protective equipment: Indicate restriction of use by pictogram or other suitable marking on or near the device.

710 ELECTRICAL INSTALLATION FOR THE BUILDING MAINTENANCE SYSTEM

- General: Install, test and commission electrical work forming part of the access equipment system up to and including wiring of isolating switch or switches provided by the electrical contractor, all in accordance with BS 7671.
- Components/ Fasteners: Use waterproof components and corrosion resisting fasteners throughout. Avoid contact between dissimilar metals.
- Control system: Designed so that an electrical supply failure, or the failure or malfunction of any electrical component, will cause the system to fail to safety.
- Failsafe provision: In the event of power failure the system must be capable of delivering the working platform to a position of safety either by hand winding or by a controlled gravity descent device.
- Isolating switches: Clearly labelled to identify purpose. Labels to display an emergency contact telephone number.

810 SERVICE/ MAINTENANCE FOR THE BUILDING MAINTENANCE SYSTEM

- General: Following acceptance of the completed installation, service and maintain the equipment for the period stated below as and at intervals recommended by the manufacturer. Such maintenance to include a ‘call-out’ service during normal working hours to maintain the equipment in an acceptable and safe condition.
- Service/ Maintenance period: 12 months.

820 OPERATING INSTRUCTIONS

- Equipment and accessories: Where appropriate, mark in such a way that it is possible to identify the correct mode of operation for their safe use.

830 OPERATING AND MAINTENANCE MANUAL

- General: Provide, for inclusion in the Building Manual, printed instructions and recommended procedures to be established by the Employer for operating and routinely maintaining the equipment. Provide diagrams where appropriate.
- Content:
  - Instructions for assembling/ erecting equipment for use.
  - Comprehensive operating instructions, including safety and emergency procedures, for all motions including upward, downward and lateral travel, and slew.
  - Servicing and planned maintenance procedures, including assembly instructions where maintenance necessitates dismantling of machinery parts.
  - List of replacement parts, with references.
  - Recommended procedures for testing equipment.

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840 AS INSTALLED DRAWINGS

- General: After commissioning/ testing of the equipment provide as installed drawings for inclusion in the Building Manual.
  - Number of sets: 3.
- Drawing content:
  - Contractor's name and contract number.
  - Location and date of installation.
  - Manufacturer's name, model and type numbers.
  - General arrangement of the complete installation.
  - Electrical circuit wiring diagrams complete with details and ratings of all items of equipment.

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P10 SUNDRY INSULATION/ PROOFING WORK

SUNDRY INSULATION/ PROOFING WORK

To be read with Preliminaries/ General Conditions.

TYPES OF INSULATION

170 INSULATION TO LOFT ACCESS HATCHES

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Material: Mineral wool mat to BS 13162.
- Recycled content: Contractor's choice.
- Thickness: as indicated.
  - Laying: Cut to fit, with no gaps, and fix securely.
- Edges of hatch: Sealed with an approved compressible draught excluder.

190 INSULATION FITTED BETWEEN STUDS

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Material: Mineral wool to BS EN 13162.
  - Facing: Metal foil laminate unless otherwise indicated.
- Recycled content: Contractor's choice.
- Thickness: minimum thickness indicated and to achieve the U value indicated.
- Installation requirements:
  - Joints: Butted, no gaps.
  - Fasteners: Use where necessary to retain insulation and/ or prevent slumping.

212 INSULATION FIXED ACROSS INNER FACE OF STUD WALLING

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Material: Mineral wool to BS EN 13162.
- Thickness: minimum thickness indicated and to achieve the U value indicated.
- Number of layers: as recommended by manufacturer to meet performance requirements.
- Installation requirements:
  - Fixing: Secure to inner face of studs, with vapour control facing (if provided) on warm side.
  - Fasteners: Staples.
  - Fixing centres: 300 mm.
  - Joints: Butt or overlap, as recommended by insulation manufacturer, with no gaps. Seal with vapour impermeable adhesive tape.

217 INSULATION SLABS FIXED TO BACKING WALL

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Material: Rock wool to BS EN 13162 unless otherwise indicated.
- Recycled content: Contractor's choice.
- Thickness: To achieve the U value indicated.
- Installation requirements:
  - Joints: Butted, no gaps. Fit insulation tightly between/ around cladding supports.
  - Fasteners: Stainless steel with minimum 70 mm diameter retaining head.

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220A SOUND INSULATION WITHIN FRAMED SEPARATING WALL

- Location: In cavity between frames.
- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Material: Mineral wool BS EN 13162.
- Recycled content: Contractor's choice.
- Density (minimum): 80 kg/m³.
- Thickness: not less than that indicated on drawings.
- Width: Widest practical.
- Installation requirements:
  - Joints: Butted, no gaps.
  - Head fixing: Staples or large head nails.

240 INSULATION FITTED BETWEEN FLOOR JOISTS

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Material: Rock wool to BS EN 13162.
- Recycled content: Contractor's choice.
- Thickness: To achieve the U value indicated.
- Installation requirements:
  - Support: 20-25 mm square mesh polyethylene net draped over joists and stapled to sides of joists. unless otherwise indicated.
  - Joints: Butted, no gaps.
  - Service holes: Sealed, and debris removed before laying insulation.

250 INSULATION SUPPORTED BETWEEN FLOOR JOISTS

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Material: Rock mineral wool slabs.
- Thickness: as indicated.
- Supports: Saddle clips.
- Installation requirements:
  - Joints: Boards butted, no gaps.

310 VAPOUR CONTROL LAYER TO CONCRETE BLOCKWORK AND WHERE INDICATED

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Material: 1000 gauge virgin polyethylene. Polyurethane coating is utilised where indicated on drawings.
- Minimum vapour resistance: 250 MN s/g.
- Installation requirements:
  - Setting out: Joints minimized.
  - Method of fixing: Primer and adhesive to concrete blockwork.
  - Joints: At supports only, lapped 150 mm minimum.
  - Openings: Membrane fixed to reveals.
  - Joints and edges: Sealed with double sided tape with vapour resistivity not less than the vapour control layer.
- Penetrations: Sealed.
- Other requirements: Prime substrates as necessary.

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410 FLEXIBLE CAVITY BARRIERS

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Material: Wired glass wool batts with density not less than 80 kg/m³.
- Fire resistance rating: To BS 476-20, matching ratings indicated in fire and life safety drawings for integrity/ insulation.
- Installation requirements:
  - Spacing: Installed in voids so the maximum unobstructed dimension in any direction is 10 m.
  - Fixing: Secure at perimeters and joints with no gaps, to provide a complete barrier to smoke and flame.

420 SLEEVED MINERAL WOOL SMALL CAVITY BARRIERS

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval considering that mineral wool density shall not be less than 80 kg/m³.
- Material: Mineral wool sleeved in polyethylene with flanges.
- Fire resistance rating: To BS 476-20, 60 integrity/ insulation.
- Size: As shown on the drawings.
- Installation requirements:
  - Fasteners: Staples at maximum 150 mm centres.
  - Vertical barriers: Fixed by both flanges.
  - Horizontal barriers: Fixed by upper flange only.
  - Joints and intersections: Butted, with barriers compressed along full length to give complete seal.

430 WIRED MINERAL WOOL SMALL CAVITY BARRIERS

- Material: Wire reinforced mineral wool minimum 50 mm thick.
- Fire resistance rating: To BS 476-20, 60 integrity/ insulation.
- Installation requirements:
  - Fasteners: Staples at maximum 150 mm centres. Fold cavity barrier if necessary to ensure a tight fit.
  - Joints and intersections: Butted, no gaps.

432 CAVITY BARRIERS

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Fire resistance rating: To BS 476-20, matching ratings indicated in fire and life safety drawings for integrity/ insulation.
- Thickness: 100 mm unless otherwise indicated.
  - Installation requirements: Continuous, with minimum joints.
  - Fasteners: Galvanized steel brackets at 500 mm centres.
- Other requirements: none.

435 VENTILATED CAVITY BARRIERS

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Material: mineral wool.
- Size: as indicated.
- Thickness: as indicated.

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- Fire resistance rating: To BS 476-20, matching ratings indicated in fire and life safety drawings for integrity/ insulation.
- Free air provision: as indicated.
- Installation requirements: Continuous, with minimum joints.
  - Fasteners: Stainless steel self-drilling screws in selvage at 300 mm centres.
- Other requirements: none.

440 FIRE PROTECTION

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Material: mineral wool with density not less than 120 kg/m³.
- Thickness: as indicated.
- Fire resistance rating: To BS 476-21, matching ratings indicated in fire and life safety drawings for integrity/ insulation.
- Number of layers: as indicated to meet fire rating required.
- Installation requirements: Continuous, with minimum joints.
  - Fasteners: as indicated.
- Other requirements: none.

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P12 FIRE STOPPING SYSTEMS

To be read with Preliminaries/ General Conditions.

GENERAL

110 FIRE STOPPING SYSTEM TO INDIVIDUAL SERVICE PENETRATIONS, TO MULTIPLE SERVICE PENETRATIONS, TO MOVEMENT JOINTS, TO EXTERNAL WALLS AND WHERE INDICATED

- Penetration seal/ Gap filler: Submit proposals.

130 FIRE STOPPING SYSTEM TO INDIVIDUAL SERVICES PENETRATIONS GENERALLY

- Fire resistance: As clause 240.
- Penetration seal: Pipe collar - surface mounted intumescent as clause 370.
  - Size: To match wall thickness.
- Capping sealant: Fire resisting silicone.
  - Colour: Submit proposals.

140 FIRE STOPPING SYSTEM TO MULTIPLE SERVICES PENETRATIONS GENERALLY

- Fire resistance: As clause 240.
- Board barrier:
  - Material: Mineral wool rigid batts - aluminium foil facing unless otherwise indicated.
    Thickness: as indicated to provide fire rating required.
    Number of layers: Two.
  - Framing: Not required.
  - Finish: Submit proposals.
- Capping sealant: Intumescent foams.
  - Colour: Submit proposals.

150 LOOSE FIRE STOPPING GENERALLY

- Fire resistance: As clause 240.
- Penetration seal: Mineral wool rigid batts - unfaced unless otherwise indicated.
  - Size: as indicated.

160 LINEAR GAP SEALING GENERALLY

- Fire resistance: As clause 240.
- Gap width or height (nominal): as indicated.
- Gap filler: Sealant backing material.
- Capping sealant: Fire resisting silicone.
  - Colour: Submit proposals.

SYSTEM PERFORMANCE

210 DESIGN

- Design: Complete the design of the fire stopping system.
- Proposals: Submit drawings, technical information, calculations and manufacturers' literature.

240 FIRE PERFORMANCE generally

- Resistance to fire: To BS 476-20 and -22, with integrity and insulation as indicated in the fire and life safety drawings and report.
- Reaction to fire: To BS EN 13501-1, class A1.
- Smoke resistance:

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- Air leakage rate (maximum): 3 $m^3/m^2 \cdot hr$.

260 DESIGN LIFE

- Effective design life: 30 years.

PRODUCTS

305 PRODUCT CERTIFICATION

- Certification: For products specified generically, submit evidence of compliance with the specification.
- Acceptable evidence: Agrément certificate or other equivalent submitted to Engineer's approval.

335 INTUMESCENT FOAM

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.

338 INTUMESCENT MASTIC

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.

342 FIRE RESISTING MORTAR

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.

360 MINERAL WOOL RIGID BATTS

- Standard: To BS EN 13162.
- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Recycled content: Contractor's choice.

370 PIPE COLLAR - CONCEALED INTUMESCENT

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.

375 PIPE COLLAR - INSULATED WRAP

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.

380 PIPE COLLAR - SURFACE MOUNTED INTUMESCENT

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.

385 SEALANT BACKING MATERIAL

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.

390 SEALANT - FIRE RESISTING SILICONE

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: To BS EN ISO 11600, class F20LM.

395 SEALANT - ONE-PART FIRE RESISTING ACRYLIC

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: To BS EN ISO 11600. class F20LM.

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EXECUTION

620 WORKMANSHIP GENERALLY

- Gaps: Seal gaps between building elements and services, to provide fire resistance and resist the passage of smoke.
- Adjacent surfaces: Prevent overrun of sealant or mortar on to finished surfaces.

640 INSTALLING BOARDING

- Position of boarding: Within opening and as indicated on drawings.
- Framing: Not required unless otherwise recommended by manufacturer.
- Bedding: Bed boarding on one-part fire resisting acrylic.
- Multiple board layers: Stagger joints between layers.
  - Joints: Seal with board adhesive.
- Fixing: Adhesive.
- Other requirements: Finish joint sealant flush with boards; rub down to receive paint finish.

660 APPLYING INTUMESCENT FOAM

- New joints: Remove builder's debris, mortar droppings, grease, and other contaminants.
- Old joints: Clean and remove existing sealant from each joint.
- Priming: Lightly moisten substrate with water.
- Application: Fill joint to approximately half its depth, and allow foam to expand to face of joint.
- Trimming: Trim excess foam to give a neat, flush appearance.

710 INSTALLING MINERAL WOOL BATTS

- Installing batts: Fit tight into void between the penetrating services and the surrounding construction to form a solid barrier.
  - Brackets: Impale batts on proprietary pressed steel brackets at 500 mm maximum centres and not greater than 250 mm from ends of batts.
    Bracket fixing: as indicated.
- Face of batts: Flush with the surface of wall, floor or soffit.
- Joints between batts: Close butt joints, seal with acoustic intumescent sealant.
- Gaps between services and barrier: Seal with fire resisting sealant.

730 FIXING PIPE COLLARS

- Collar fixing: Submit proposals.
- Gap around collar: Seal with intumescent foam.
- Length of wraps: Project 50 mm from each side of the element.

740 INSERTING SEALANT BACKING MATERIAL

- Preparation: Removed debris from service penetration.
- Installation: Insert joint filler to full depth of joint leaving sufficient depth to apply sealant.

745 APPLYING SEALANTS GENERALLY

- Application: As section Z22.

750 APPLYING CAPPING SEALANT

- Preparation: De-grease using cleaner recommended by sealant manufacturer.
- Priming: Primer recommended by sealant manufacturer.
- Depth of sealant: as recommended by manufacturer to meet required fire rating.
- Temperature: Do not apply water based sealants when they could be damaged by frost.

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COMPLETION

910 CLEANING

- Masking tapes: Remove.
- Cleaning: Clean off splashes and droppings. Wipe down finishes.

920 INSPECTION

- Notice for inspection (minimum): 5 working days as directed by Engineer.

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P20 UNFRAMED ISOLATED TRIMS/ SKIRTINGS/ SUNDRY ITEMS

To be read with Preliminaries/General Conditions

120 HARDWOOD SKIRTINGS GENERALLY

- Quality of wood and fixing: To BS 1186-3.
  - Species: as shown on drawings.
  - Class: 1.
- Moisture content at time of fixing: 13-19%.
- Preservative treatment: Water-based microemulsion as section Z12, service life 60 years.
- Fire rating: To BS 476-7, Class 1.
- Profile: As shown on drawings.
  - Finished size: As drawing.
- Finish as delivered: Prepared and primed as section M60.
- Fixing: Adhesive as section Z20.

170A CORNER GUARDS WHERE INDICATED

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Severe duty flush mounted corner guard.
- Shock absorbing cover over flush mounted continuous aluminium retainer
- Free-floating design flexes on impact.
- Continuous shock-absorbing cushion for added impact protection.
- Suitable for surface mounting.
- For plasterboard fixation, a two-stage fix product shall be installed, aluminium retainer is installed at the same time as plasterboard, then covers are installed as part of second fix works.
- Engineered PETG free of PVC and PBTs
- 5 year warranty

170D WALL GUARDS WHERE INDICATED

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Size: As drawings.
- Finish/ Colour: Black rubber, unless otherwise indicated..
- Description: Wall guard made of heavy-duty rubber, mechanically fixed with screws. The E-fender profiles can be installed onto practically any substrate, including concrete, brickwork, and blockwork. Suitable for both interior and exterior environments.
- Fire performance:
  - Sheet shall be classified as class B-s1, d0 in accordance with BS EN 13501-1: 2007+A1: 2009.
- Impact and abrasion resistance:
  - Rubber profile shall provide a tough, through-coloured and textured surface finish, which is resistant to impact and abrasion. Tested in accordance with ASTM D 4060-07 for abrasion resistance and to ASTM F 476-84 (Reapproved 2002) for resistance to impact.
- Chemical, fungal and bacterial resistance:
  - wall guard sheet shall be formulated to resist most commonly used chemical solutions and doesn't propagate the growth of bacteria on a clean surface. However, anti-bacterial properties of the product do not negate the need for a rigorous cleaning regime as recommended by manufacturer.
- Thermal performance:

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- Wall guard sheet will expand and contract in the order of 0.09 mm/ m for every one degree Celsius rise or fall.

170E WALL GUARDS CLADDING WHERE INDICATED

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Size: 1/8" thick stainless steel; Inside corners: 50.8mm; Outside corners: 88.9mm.
- Finish/ Colour: Stainless Steel, Mill finish; Top trim: black flexible vinyl.
- Description: Stainless steel diamond plate system with inside/outside corners cut and bent. Includes a black flexible vinyl bumper top trim mounted on a continuous aluminum retainer. Suitable for waste areas and corridors.
- Fire performance:
  - Sheet shall be classified as class B-s1, d0 in accordance with BS EN 13501-1: 2007+A1: 2009.
- Impact and abrasion resistance:
  - 1/8" thick diamond plate shall provide a tough, textured surface finish resistant to impact and abrasion. Tested in accordance with ASTM D 4060-07 for abrasion resistance and to ASTM F 476-84 for resistance to impact.
- Chemical, fungal and bacterial resistance:
  - Stainless steel cladding can be exposed to chemicals and temperature extremes without adverse effect and doesn't propagate the growth of bacteria on a clean surface. However, anti-bacterial properties do not negate the need for a rigorous cleaning regime.
- Thermal performance:
  - Wall guard system will expand and contract in the order of 0.09 mm/ m for every one degree Celsius rise or fall.

170G CORNER GUARDS Stainless steel corner guard

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Dimensions: 75 x 75 mm, unless otherwise indicated in the finishes manual.
  With slightly cranked edges to provide approximately 1.5 mm void behind corner guards to accommodate wall irregularities.
  - Corner guard shall be fabricated from Type 304 or 430 stainless steel angles with radiused corners.
  - Thickness: As per manufacturer's standard.
  - Shall be Designed to offer heavy duty protection for 90° , 135°, or custom corners angles.
  - Finish: Satin stainless steel finish.
  - Corner guards shall have cranked edges to provide approx. 1.5 mm void behind guards to accommodate wall irregularities.
  - Corner guards shall be Installed with construction using mechanical fixing or adhesive fixing, as per manufacturer's recommendations.
  - Length: Continuous lengths up to 3000 mm (10 feet) maximum.

170I CORNER GUARDS CORNER GUARDS WHERE INDICATED

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Black EPDM rubber corner guards, with tapered profiles and radiused corners.
- Designed for heavy duty interior applications, offering protection against vehicular traffic, trolleys and carts.
- Excellent shock absorbing and weather resistant qualities.

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- Can be fixed directly to concrete, steel, masonry and timber.
- 100C model is grooved on the internal surface to effect greater adhesion.
- Available in two sizes: 100C - 100 mm x 100 mm and 75C - 75 mm x 75 mm to be selected by Engineer.

410 LEG SUPPORTS FOR COUNTER TOP

- Material: Stainless steel .
  - Finish: Brushed .
  - Colour: natural .
- Dimensions:
  - Profile: As shown on drawings .
  - Height: As shown on drawings .
- Fixing: As shown on drawings .

420 BRACKET SUPPORTS FOR WORKTOPS AND SHELVES

- Material: stainless steel as indicated on drawings.
  - Finish: Brushed.
  - Colour: stainless steel natural colour.
- Size: As shown on drawings.
- Fixing: As shown on drawings.

510 INSTALLATION GENERALLY

- Joinery workmanship: As section Z10.
- Metal workmanship: As section Z11.
- Methods of fixing and fasteners: As section Z20 where not specified.
- Straight runs: To be in one piece, or in long lengths with as few joints as possible.
- Running joints: Location and method of forming to be agreed where not detailed.
- Joints at angles: Butt joints, unless shown otherwise.
- Position and level: To be agreed where not detailed.

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P21 DOOR/ WINDOW IRONMONGERY

To be read with Preliminaries/ General Conditions.

PRE-TENDER

10 QUANTITIES AND LOCATIONS

- Quantities and locations of ironmongery are in the ironmongery schedule.
- Fixing: As sections L10 and L20.

GENERAL

120 IRONMONGERY RANGE SELECTED BY CONTRACTOR

- Source: Single co-ordinated range.
- Notification: Submit details of selected range, manufacturer and/ or supplier.
- Principal material/ finish: Satin stainless steel, grade 1.4401 (316).
- Items unavailable within selected range: Submit proposals.

140 SAMPLES

- General: Before placing orders with suppliers submit labelled samples of the following: as indicated by Engineer.
  - Conformity: Retain samples on site for the duration of the contract. Ensure conformity of ironmongery as delivered with labelled samples.

141 SAMPLE BOARDS

- General: Before placing orders with suppliers submit a sample board, containing labelled samples of ironmongery and showing methods of fixing.
- Range: Include as indicated by Engineer.
  - Conformity: Retain board on site in an approved location for the duration of the contract. Ensure conformity of ironmongery as delivered with labelled samples.

170 IRONMONGERIES FOR FIRE DOORS

- Relevant products: Ironmongery fixed to, or morticed into, the component parts of a fire resisting door assembly.
- Compliance: Ironmongery included in successful tests to BS 476-22 or BS EN 1634-1 on door assemblies similar to those proposed.
  - Certification: Submit evidence of successful testing by an accredited laboratory or submit CERTIFIRE certificates or submit to Engineer's approval.
- Melting point of components (except decorative non-functional parts): 800°C minimum.

180 STRENGTH CLASS OR CATEGORY OF DUTY FOR DOOR IRONMONGERY

- Requirement:
  - In accordance with DD 171, Heavy duty or severe duty where indicated in door hardware schedule.
  - To BS EN 1192, Class 3-4.
  - As schedule; and
- As drawings.
- General: Durability of ironmongery components to be compatible with stated category of duty of each door leaf.
  - Exclusions: Ironmongery with specific duty or 'category of use' defined elsewhere.
  - Documentation: Before placing orders with suppliers submit documentation showing product compliance with stated category of duty.

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DOOR HANGING DEVICES

310 SINGLE AXIS DOOR HINGES as indicated

- Standard: To BS EN 1935.
  - Hinges to doors on escape routes and fire/ smoke control doors: CE marked.
- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Type: Double ball bearing butt.
- Size: As schedule.
- Material/ finish: Satin stainless steel, grade 1.4401 (316).
- Hinge grade: 13.
- Other requirements: Security dog bolt.

315 PERFORMANCE SPECIFICATION FOR SINGLE AXIS DOOR HINGES as indicated

- Standard: To BS EN 1935.
  - Hinges to doors on escape routes and fire/ smoke control doors: CE marked.
- Minimum classification grades:
  - Category of use: 3 and 4.
  - Durability: 7 for 200000 test cycles.
  - Test door mass: grade 6 for 120 Kg or grade 7 for 160 Kg.
  - Suitability for use on fire/ smoke doors: 1.
  - Safety: 1.
  - Corrosion resistance: 4.
  - Security - Burglar resistance: 1.
  - Hinge grade: 14.
- Type: As schedule.
- Size: As schedule.
- Material/ finish: Satin stainless steel, grade 1.4301 (304).
- Other requirements: Radiused corners or security dog bolt.

320 DOOR HINGES as schedule

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Type: As schedule.
- Size: As schedule.
- Material/ finish: Satin stainless steel, grade 1.4401 (316).
- Other requirements: None.

WINDOW HANGING DEVICES

365 SINGLE AXIS WINDOW HINGES GENERALLY

- Standard: To BS EN 1935.
- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Type: As schedule.
- Size: As schedule.
- Material/ finish: Satin stainless steel, grade 1.4401 (316).
- Hinge grade: not less than 9.
- Other requirements: None.

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370 WINDOW HINGES GENERALLY

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Type: Plain bearing butt unless otherwise indicated on schedule.
- Size: As schedule.
- Material/ finish: Satin stainless steel, grade 1.4401 (316).

385 PIVOT HINGES GENERALLY

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Type: Reversible horizontal pivots with integral restrictor.
- Material/ finish: As schedule.

DOOR OPERATING DEVICES

410 OVERHEAD DOOR CLOSERS GENERALLY

- Standard: To BS EN 1154.
  - Door closing devices to fire/ smoke control doors: CE marked.
- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Type: Concealed except on fire doors.
- Power size: Adjustable 2-6.
- Other functions: Delayed closing.
- Casing finish: Powder coated; colour as indicated on schedule.
- Operational adjustment:
  - Variable power: Matched to size, weight and location of doors.
  - Latched doors: Override latches and/ or door seals when fitted.
  - Unlatched doors: Hold shut under normal working conditions.
  - Closing against smoke seals of fire doors: Positive. No gaps.

412 PERFORMANCE SPECIFICATION FOR OVERHEAD DOOR CLOSERS WHERE INDICATED

- Standard: To BS EN 1154.
  - Door closing devices to fire/ smoke control doors: CE marked.
- Minimum classification grades:
  - Category of use: 4.
  - Durability: 8.
  - Door closer power size: Adjustable 3-6.
  - Suitability for use on fire/ smoke doors: 1.
  - Safety: 1.
  - Corrosion resistance: 3 to 4.
- Type: Concealed except on fire doors.
- Other functions: Delayed closing.
- Casing finish: Powder coated; colour as indicated.
- Operational adjustment:
  - Variable power: Matched to the sizes and weights of doors.
  - Latched doors: Override latches and/ or door seals when fitted.
  - Unlatched doors: Hold shut under normal working conditions.
  - Closing against smoke seals of fire doors: Positive. No gaps.

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452 PERFORMANCE SPECIFICATION FOR FLOOR SPRINGS GENERALLY

- Standard: To BS EN 1154.
  - Door closing devices to fire/ smoke control doors: CE marked.
- Minimum classification grades:
  - Category of use: 4.
  - Durability: 8.
  - Door closer power size: Adjustable 3-6.
  - Suitability for use on fire/ smoke doors: 1.
  - Safety: 1.
  - Corrosion resistance: 3.
- Other functions: Delayed closing.
- Material/ finish: Powder coated steel; colour as indicated.
  Operational adjustment:
  - Variable power: Matched to size, weight and location of doors.
  - Latched doors: Override latches and/ or door seals when fitted.
  - Unlatched doors: Hold shut under normal working conditions.

472 PERFORMANCE SPECIFICATION FOR ELECTROMAGNETIC HOLD OPEN/ SWING-FREE DEVICES (24 V) GENERALLY

- Standard: To BS EN 1155.
  - Electromagnetic devices to fire/ smoke control doors: CE marked.
- Type: Hold open, separate floor mounted, unless scheduled otherwise.
- Minimum classification grades:
  - Category of use: 3.
  - Durability: 8.
  - Hold open power size: 6.
  - Suitability for use on fire/ smoke doors: 1.
  - Safety: 1.
  - Corrosion resistance: 3.
- Material/ finish: As schedule.
- Means of release: Alarm system and/ or failure of power supply.
- Test switch: Located in a convenient position adjacent to door.
- Operational adjustment of integral closer:
  - Variable power: Matched to size, weight and location of doors.
  - Latched doors: Override latches and/ or door seals when fitted.
  - Unlatched doors: Hold shut under normal working conditions.

482 PERFORMANCE SPECIFICATION FOR DOOR COORDINATORS GENERALLY

- Standard: To BS EN 1158.
  - Door coordinators to fire/ smoke control doors: CE marked.
- Minimum classification grades:
  - Category of use: 3.
  - Durability: 8.
  - Door coordinator size: 6.
  - Suitability for use on fire/ smoke doors: 1.
  - Safety: 1.
  - Corrosion resistance: 3.
- Material/ finish: Powder coated steel; colour as indicated.
- Application: To all single swing double doors with rebated meeting stiles and fitted with self-closers.
- Selection criteria: Provide types that:

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- Require the minimum amount of material to be removed from the door and frame.
- Are suitable for the size of rebates.

490 UNCONTROLLED DOOR CLOSERS GENERALLY

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Type: Concealed.
- Material/ finish: As schedule.
- Action: As schedule.
- Operation:
  - Power: To suit the size and weight of doors to which they are fitted.
  - Unlatched doors: Hold closed under normal conditions.

DOOR SECURING DEVICES

525 PERFORMANCE SPECIFICATION FOR DOOR LOCKS AND LATCHES GENERALLY

- Standard: To BS EN 12209.
- Minimum classification grades:
  - Category of use: 3.
  - Durability: W.
  - Door mass and closing force: 8.
  - Suitability for use on fire/ smoke doors: 1.
  - Safety: 0.
  - Corrosion resistance and temperature: E.
  - Security and drill resistance: 5.
  - Field of door application: N.
  - Type of key operation and locking: A.
  - Type of spindle operation: 4.
  - Key identification requirement: G.
- back set: As schedule.
- Material/ finish: As schedule.
- Keying: In master keyed suite.

540 DOOR LATCHES GENERALLY

- Standard: To BS EN 12209.
- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Type: As schedule.
- back set: As schedule.
- Material/ finish: Stainless steel faceplate.
- Latch spring strength: Select to prevent unsprung lever handles drooping.

566 PERFORMANCE SPECIFICATION FOR PADLOCKS GENERALLY

- Standard: To BS EN 12320.
- Minimum classification grades:
  - Category of use: – Grade 1.
  - Durability: 1
  - Corrosion resistance: 4.
  - Security: 5.
- Size: As schedule.

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- Case: As schedule.
- Shackle: As schedule.
- Accessories: As schedule.
- Keying: In master keyed suite.

572 PERFORMANCE SPECIFICATION FOR EMERGENCY EXIT DEVICES GENERALLY

- Standard: To BS EN 179.
  - Emergency exit devices for locked doors on escape routes: CE marked.
- Minimum classification grades:
  - Category of use: 3.
  - Durability: 7.
  - Door mass: 6.
  - Suitability for use on fire/ smoke doors: 1.
  - Safety: 1.
  - Corrosion resistance: 4.
  - Security: 4.
  - Projection of operating element: 2.
  - Type of operation: B: Push pad operation.
- Material/ finish: Satin stainless steel.
- Additional requirements: Security alarmed.

578 PERFORMANCE SPECIFICATION FOR PANIC EXIT DEVICES GENERALLY

- Standard: To BS EN 1125.
  - Panic exit devices for locked doors on escape routes: CE marked.
- Minimum classification grades:
  - Category of use: 3.
  - Durability: 6.
  - Door mass: 6.
  - Suitability for use on fire/ smoke doors: 1.
  - Safety: 1.
  - Corrosion resistance: 4.
  - Security: 2.
  - Projection of bar: 2.
  - Type of bar operation: A: Push bar operation.
- Material/ finish: Satin stainless steel.
- Additional requirements: Security alarmed.

584 PERFORMANCE SPECIFICATION FOR DOOR BOLTS GENERALLY

- Standard: To BS EN 12051.
- Minimum classification grades:
  - Category of use: 3.
  - Number of test cycles: 4.
  - Door mass: - (no classification).
  - Fire safety: 1.
  - Safety in use: 1.
  - Corrosion resistance: 3.
  - Security: 4.
- Type: As schedule.
- Size: As schedule.
- Material/ finish: Satin stainless steel, grade 1.4401 (316).

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- Additional requirements: None.

585 PERFORMANCE SPECIFICATION FOR CYLINDERS GENERALLY

- Standard: To BS EN 1303.
- Minimum classification grades:
  - Category of use: 1
  - Durability: 6 (100,000 cycles)
  - Door mass: Not graded
  - Fire resistance: 1 (suitable for fire/smoke doors)
  - Safety: 1
  - Corrosion resistance: 3
  - Security grade: 6 (for master keyed systems)
  - Attack resistance: 2
- Type: Thumb turn
- Size: As per schedule
- Material/finish: Satin stainless steel (Grade 316)
- Keying: In master keyed suite

586 PERFORMANCE SPECIFICATION FOR DUST PROOF STRIKES

- Standard: Manufacturer's tested product to match bolt
- Minimum classification grades:
  - Durability: Minimum 100,000 cycles
  - Corrosion resistance: Grade 3
- Type: Floor-mounted strike
- Size: Adjustable faceplate
- Material/finish: Satin stainless steel, Grade 316
- Additional requirements: Recessed flush finish

DOOR FURNITURE

610 LEVER HANDLES GENERALLY

- Standard: To BS EN 1906.
- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Style: As schedule.
- Size: As schedule.
- Material/ finish: Satin stainless steel, grade 1.4401 (316) As schedule.
- Mounting: As schedule.
- Additional requirements: None.

622 PERFORMANCE SPECIFICATION FOR LEVER HANDLE SETS GENERALLY

- Standard: To BS EN 1906.
- Minimum classification grades:
  - Category of use: Grade 4: High frequency with frequent violent usage.
  - Durability: Grade 7: 200 000 test cycles.
  - Door mass: - (no classification).
  - Fire resistance: Grade D1: For use on smoke control and fire resistant door assemblies with requirements for special core in the handle/ knob, tested with 200 000 cycles on a test door.
  - Safety: Grade 1: Safety applications.
  - Corrosion resistance: Grade 4: Very high resistance.
  - Security: Grade 2: Moderate burglary resistance.
  - Type of operation: Type B: Spring loaded furniture.

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- Style: As schedule.
- Size: As schedule.
- Material/ finish: As schedule.
- Mounting: As schedule.
- Additional requirements: None.

625 PERFORMANCE SPECIFICATION FOR KNOBSETS GENERALLY

- Standard: To BS EN 1906.
- Minimum classification grades:
  - Category of use: 3.
  - Durability: 7.
  - Door mass: - (no classification).
  - Fire resistance: D.
  - Safety: 1.
  - Corrosion resistance: 4.
  - Security: 3.
  - Type of operation: B.
- Style: As schedule.
- Size: As schedule.
- Material/ finish: Satin stainless steel, grade 1.4401.
- Mounting: As schedule.
- Additional requirements: None.

651 PERFORMANCE SPECIFICATION FOR PULL HANDLES GENERALLY

- Standard: To BS 8424.
- Minimum classification grades:
  - Category of use: 3.
  - Durability: 2.
  - Door mass: - (no classification).
  - Suitability for use on fire/ smoke doors: 1.
  - Safety: 1.
  - Corrosion resistance: 3.
- Shape: As schedule.
- Diameter: As schedule.
- Distance between centres: As schedule.
- Material/ finish: Satin stainless steel, grade 1.4401 (316).
- Mounting: As schedule.
- Additional requirements none.

670 PUSH PLATES GENERALLY

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Size: As schedule.
- Material/ finish: Satin stainless steel, grade 1.4401 (316).
- Mounting: As schedule.
- Additional requirements: None.

690 KICK PLATES where indicated

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.

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- Size: As schedule.
- Material/ finish: As schedule.
- Mounting: As schedule.
- Additional requirements: Rounded edges and radiused corners.

720 DOORSTOPS

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Type: As schedule.
- Usage: As schedule.

731 PERFORMANCE SPECIFICATION FOR LETTER PLATES where indicated

- Standard: To BS EN 13724.
- Minimum classification grades:
  - Type of aperture: 4.
  - Aperture size: 3, unless otherwise indicated.
  - Corrosion resistance: 3 to 4.
  - Security: 2.
- Operation: As schedule.
- Material/ finish: Satin stainless steel, grade 1.4401 (316), unless otherwise scheduled.
- Features: None.

760 DOOR HOLDERS WHERE INDICATED

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Type: Gravity hook.
- Size: As schedule.
- Material/ finish: Satin stainless steel, grade 1.4401 (316).

855 WEATHERSTRIP TO DOOR HEAD AND JAMBS WHERE INDICATED

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Type: Elastomeric compression strip in metal carrier.
- Size: to suit doors, as manufacturer's recommendations.
- Material/ finish: As schedule.

860 DOOR SEALS FOR locations indicated

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Type: Elastomeric compression strip in metal carrier.
- Size: to suit doors, as manufacturer's recommendations.
- Material/ finish: As schedule.

860A PERFORMANCE SPECIFICATION FOR AUTOMATIC DROP SEALS

- Standard:
  - Fire: BS EN 1634-1
  - Smoke: BS EN 1634-3
  - Acoustic: BS EN ISO 10140
- Minimum performance requirements:
  - Concealed, heavy duty
  - Fire rated: Minimum 60 minutes

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  - Acoustic: ≥ 30 dB
- Type: Drop-down, spring-loaded
- Material/finish: Aluminium body with neoprene insert
- Additional requirements: Coordinate with sill detail

900 CASEMENT HANDLES GENERALLY

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Type: As schedule.
- Material/ finish: Satin stainless steel, grade 1.4401 (316).
- Features: None.

905 CASEMENT STAYS GENERALLY

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Type: As schedule.
- Size: As schedule.
- Material/ finish: Satin stainless steel, grade 1.4401 (316).
- Features: None.

910 WINDOW LEVER HANDLES WHERE INDICATED

- Manufacturer: Submit proposals to Engineer's approval.
  - Product reference: Submit proposals to Engineer's approval.
- Type: As schedule.
- Material/ finish: Satin stainless steel, grade 1.4401 (316).
- Features: None.

925 OVER CENTRE CASEMENT STAYS WHERE INDICATED

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Type: As schedule.
- Size: As schedule.
- Material/ finish: As schedule.
- Features: None.

930 FRICTION RESTRICTOR CASEMENT STAYS WHERE INDICATED

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Type: As schedule.
- Size: As schedule.
- Material/ finish: As schedule.
- Features: None.

940 SASH LIFT HANDLES WHERE INDICATED

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Type: As schedule.
- Size: As schedule.
- Material/ finish as schedule.

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950 SASH EYES WHERE INDICATED

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Type: As schedule.
- Size: As schedule.
- Material/ finish: As schedule.

960 WEATHERSTRIP TO WINDOWS WHERE INDICATED

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Type: As schedule.
- Size: As schedule.
- Material/ Finish: As schedule.

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P31 HOLES, CHASES, COVERS AND SUPPORTS FOR SERVICES

To be read with Preliminaries/ General Conditions.

PRODUCTS

370 ACCESS COVERS/ GRATINGS FOR FLOOR TRENCHES

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Covers/ Gratings: Gratings to be heavy duty Hot dip galvanized mild steel recessed pattern with granolithic topping Open gratings. Where indicated, sump pits to receive 6 mm thick aluminium sheets with diamond checkered pattern with stainless steel butt hinges and tamperproof stainless steel bolts and nuts.
  - Sizes: 6 mm thick plate and as drawings.
  - Loading grade: Class A, Class B, Class C, Class D, Class E, or Class F to BS EN 124.
- Frame/ Support/ Fixing: Frame cast in using integral anchors, covers fixed with corrosion resistant locking screws, or stainless steel class A2 where indicated on drawings.
- Accessories: as indicated.

370A CHECKERED PLATE COVERS FLOOR TRENCHES

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Covers/ Gratings: Hot dip galvanized mild steel checkered pattern. Where indicated, covers to be of cast iron to BS EN 1563.
  - Sizes: 6 mm thick plate and as drawings.
  - Loading grade: Class A, Class B, Class C, Class D, Class E, or Class F to BS EN 124.
- Frame/ Support/ Fixing: Frame cast in using integral anchors, covers fixed with corrosion resistant locking screws, or stainless steel class A2 where indicated on drawings.
- Accessories: as indicated.

370B ACCESS COVERS/ MANHOLE TOPS AND FRAMES generally

- Standard: To BS EN 124.
- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Material: Grey Iron or Ductile iron or Steel or Aluminium.
- Types: A15 for pedestrian use, or B125 for light traffic, or C250 for slow moving heavy traffic, or D400 for carriageway use, or E600 for loading dock use, or F900 for airport use.

370E MORTAR BEDDING

- Mix: 1:3 sulfate-resisting cement:sand.

370F WARNING MARKER TAPES

- Standard: To BS EN 12613.
- Type: Continuous colour coded, heavy gauge polyethylene identification tapes.
- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Width: 150 mm.
- Colour: Yellow with black lettering.
- Wire detection aid: Required.

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370G WARNING MARKER TILES

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Material: Reinforced precast concrete tiles.
- Size: as indicated with pitched top.

EXECUTION

610 COORDINATION

- Locations and dimensions of holes and chases for services: Submit details as directed by Engineer.

620 HOLES, RECESSES AND CHASES IN IN SITU CONCRETE

- Cast in: Holes larger than 10 mm diameter, recesses and chases.
- Cutting and drilling:
  - Permitted for holes not larger than 10 mm diameter.
  - Not permitted for holes larger than 10 mm diameter except as indicated on drawings.

640 HOLES IN STRUCTURAL STEELWORK

- Cutting and drilling: Not permitted except as indicated on drawings.

650 HOLES, RECESSES AND CHASES IN MASONRY

- Locations: To maintain integrity of strength, stability and sound resistance of construction.
- Sizes: Minimum needed to accommodate services.
  - Holes (maximum): 300 mm².
- Walls of hollow or cellular blocks: Do not chase.
- Walls of other materials:
  - Vertical chases: No deeper than one third of single leaf thickness, excluding finishes.
  - Horizontal or raking chases: No longer than 1 m. No deeper than one sixth of the single leaf thickness, excluding finishes.
- Chases and recesses: Do not set back to back. Offset by a clear distance at least equal to the wall thickness.
- Cutting: Do not cut until mortar is fully set. Cut carefully and neatly. Avoid spalling, cracking and other damage to surrounding structure.

660 PREFORMED HOLES IN MASONRY

- Width of holes without bridging over (maximum): 460 mm.
  - Holes requiring bridging: Submit proposals.

690 INSTALLING PIPE SLEEVES

- Sleeves: Fit to pipes passing through building fabric.
- Material: Match pipeline.
- Size: One or two sizes larger than pipe to allow clearance.
- Finish: Install sleeves flush with building finish. In areas where floors are washed down, install protruding 100 mm above floor finish.
- Masking plates: Fit at visible penetrations, including through false ceilings of occupied rooms.

730 INSTALLING ACCESS COVERS/ GRATINGS AND FRAMES

- Seating: concrete and as indicated.
- Bedding and haunching of frames: Continuously.
  - Material: 1:3 cement:sand mortar.
  - Top of haunching: 30 mm below surrounding surfaces.
- Horizontal positioning of frames:

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  - Centred over openings.
  - Install square with joints in surrounding surfaces: Wherever practicable.
- Vertical positioning of frames:
  - Level; or
  - Marry in with levels of surrounding surfaces.
- Permissible deviation in level of external covers and frames: +0 to -6 mm.

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Q28 - TOPSOIL AND SOIL AMELIORANTS

To be read with Preliminaries/ General conditions.

TESTING OF MATERIALS

Preconstruction testing of **existing, on-site soil and imported soil** by **Contractor's** testing agency.

SYSTEM OUTLINE

110 PLANTING SOILS PRODUCED BY MODIFYING THE FOLLOWING SOIL SOURCES:

- Existing, On-Site Surface Soil **Stockpiled On-Site**
- Imported Soil
- Manufactured Soil:

120 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

- Excavate soil to a depth of (**150 mm)** and stockpile until amended.
- Screen soil with a **(75-mm)** sieve to remove large materials.

130 PLACING AND MIXING PLANTING SOIL OVER EXPOSED SUBGRADE

- Till subgrade to depth of (**450 mm)**.
- Spread unamended soil to total depth of **(300 mm)** and amend in place.
- Compact each lift of planting soil.

140 PLACING MANUFACTURED PLANTING SOIL OVER EXPOSED SUBGRADE

- Till subgrade to depth of **(450 mm)**.
- Spread planting soil to total depth of **(300 mm)**.
- Compact each lift of planting soil.

150 BLENDING PLANTING SOIL IN PLACE.

- Till unamended, existing soil to depth of **(450 mm)**.
- Apply amendments and blend.
- Compact blended planting soil.

160 LAYERED SOIL ASSEMBLIES

- Layered Soil Assembly planting soil layers.

170 FIELD QUALITY CONTROL

- Testing Agency: **Contractor** engaged.

Q50B SITE/ STREET FURNITURE/ EQUIPMENT

To be read with Preliminaries/ General Conditions.

190 BOLLARDS Where Indicated

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Material: ,Stainless Steel Grade 316 or A4.
  - Finish as delivered:
  - Brushed;
  - Satin polished; unless otherwise indicated
- As manufactured.
  - Colour: To BS 4800, or RAL colour range, colour as selected by Engineer from Manufacturer's full range.
- Height above ground: As drawings.
- Sectional size: as drawings.
- Top: Angled or Domed or Flat or Pyramid.
- Special features:
  - Two eye bolts;
  - Single eye bolt;
  - Yellow reflective band, 150 mm high at top of bollard;
  - Red and white reflective band, 150 mm high at top of bollard;
  - Red reflective band, 150 mm high at top of bollard; and
- White reflective band, 150 mm high at top of bollard.
- Method of fixing: Base plate bolted to 400 x 400 x 400 mm concrete base 100 mm below paving surface or Base plate bolted to existing in situ concrete paving or Root, 300 mm below ground, set in concrete base.

196 REMOVABLE BOLLARDS GENERALLY

- Manufacturer: Submit proposals.
  - Product reference: Submit proposals.
- Material: Stainless Steel Grade 304 or A4.
  - Finish as delivered:
  - Satin polished; unless otherwise indicated.
- As manufactured.
  - Colour: To BS 4800, or to RAL colour range.
- Height above ground: As drawing.
- Sectional size: as drawing.
- Top: Angled or domed or flat or pyramid.
- Special features:
  - Recess cover plate;
  - Lifting handle ;
  - Lock;
  - Logo as drawing;
  - Two eye bolts;
  - Single eye bolt;
  - Yellow reflective band, 150 mm high at top of bollard;
  - Red and white reflective band, 150 mm high at top of bollard;
  - Red reflective band, 150 mm high at top of bollard; and

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- White and red reflective band as drawing.
- Method of fixing: Concrete base with manufacturer's standard lockable socket or as indicated on drawings.

INSTALLATION

510 CONCRETE FOUNDATIONS GENERALLY

- Standard: To BS 8500-2.
- Concrete:
  - As section E10;
  - or Designated, not less than GEN 1; and
- Or Standard prescribed, not less than ST2.
- Admixtures: Do not use.
- Foundation holes: Neat vertical sides.
- Depth of foundations, bedding, haunching: Appropriate to provide adequate support and to receive overlying soft landscape or paving finishes.

515 SETTING COMPONENTS IN CONCRETE

- Holes: 250 x 250 x minimum 300 mm deep, unless otherwise indicated on drawings and as per manufacturer's recommendations.
- Components: Accurately positioned and securely supported.
- Concrete fill: Fully compacted as filling proceeds.
- Concrete foundations exposed to view: Compacted until air bubbles cease to appear on the upper surface, then weathered to shed water and trowelled smooth.
- Temporary component support: Maintain undisturbed for minimum 48 hours.

520 SETTING IN EARTH

- Holes: As small as practicable.
- Components being fixed: Accurately positioned and securely supported.
- Buried depth (minimum): 450 mm unless otherwise recommended by manufacturer.
- Earth refill: Well rammed as filling proceeds.

540 BUILDING IN TO MASONRY WALLS

- Components being built in: Accurately positioned and securely supported. Set in mortar and pointed neatly to match adjacent walling.
- Temporary support: Maintain for 48 hours (minimum) and prevent disturbance.

550 DAMAGE TO GALVANIZED SURFACES

- Minor damage in areas up to 40 mm² (including on fixings and fittings): Make good.
  - Material: Low melting point zinc alloy repair rods or powders made for this purpose or at least two coats of zinc-rich paint to BS 4652.
  - Thickness: Sufficient to provide a zinc coating at least equal to the original layer.

560 SITE PAINTING

- Timing: Prepare surfaces and apply finishes as soon as possible after fixing.

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R10A - RAINWATER PIPEWORK AND GUTTERS

To be read in parallel with section R10B (Architecture)

PART 3 SPECIFICATION CLAUSES SPECIFIC TO R10

300.000 GENERAL / PRODUCT / MATERIALS

300.005 GENERAL:

- Install, commission and set to work a roof drainage system operating under gravity inside the building in accordance with BS EN 12056-3
- For siphonic drainage systems comply with the performance requirements in BS EN 12056-3 and the guidance given in BS 8490

300.090 ROOF OUTLETS:

- Standard
  - BS EN 1253-2
- Type : with emergency overflow
  - Material
  - Cast iron with large sump and flange, with removable non-clogging flush-mounted strainer and flashing clamp device to BS 416-1 Gratings
    - Domical.

300.110 BALCONY OUTLETS:

- Standards
  - BS EN 1253-2
- Material
- [Cast iron with large sump and flange, with removable non-clogging flush-mounted strainer and flashing clamp device to BS 416-1] Gratings

310.000 WORKMANSHIP

310.010 INSTALLATION GENERALLY:

- Install in accordance with BS 8000-13, BS EN 12056-5 and manufacturer's recommendations to ensure complete discharge of rainwater from building without leaking.
- Handle, store and securely fix all products and accessories in accordance with manufacturer's recommendations.
- Inspect components before fixing and reject any which are defective. Ensure cut ends are clean and square with burrs removed.
- Where not indicated otherwise use plated, sheradized, galvanized or non-ferrous fastenings, suitable for purpose and background, and compatible with material being fixed.

310.020 BEFORE COMMENCING WORK:

- Before commencing work ensure that below ground drainage is ready to receive rainwater or that the discharge can be dispersed by approved means to prevent damage or disfigurement of

the building fabric. Ensure any specific painting of surfaces which will be concealed or otherwise inaccessible, is completed.

310.130 ACCESS POINTS:

- Provide rodding and access points at all changes of direction to enable whole system to be maintained.
- Provide square door type access points as indicated on drawings at foot of all rainwater stacks, and at other locations on the stacks as indicated on the drawings.
- Fit covers, caps, etc. as work proceeds to prevent ingress of dirt and building materials.

310.140 RAINWATER OUTLETS:

- Fix a grating or cage to restrict entry of solids to system.

310.150 ROOF AND BALCONY OUTLETS:

- Ensure that outlets are securely fixed before connecting pipework.
- Ensure junctions between outlets and pipework can accommodate all movement in roof decking and pipework.

320.040 DOWNPIPE TERMINATION:

- Terminate downpipes to discharge freely at ground level 500mm above finished floor level through the external wall

320.050 DESIGN PARAMETERS:

- Rainfall intensity (mm/hr) 290
- Pipe pressure range
  - Between 4.0 and -0.8 bar gauge pressure.
- Water velocity
  - Above 1m/s and not in excess of 8m/s.

320.080 RAINWATER OUTLETS:

- Material
  - Galvanized mild steel.
- Gutter material
  - Galvanized mild steel.
- Provide all outlets with leaf guards.
- Use
  - Clamp ring outlet.
  - Suitable for heat bonding into membrane.
  - Suitable for welding into gutters.
  - Trafficable.
- Incorporate an upper flange for fixing; a baffle arrangement to inhibit the formation of vortices and entrainment of air into pipe system.
- On secondary outlets incorporate an upstand.

320.100 WORKMANSHIP:

- Fittings
  - Install eccentric reducers in horizontal flows so that the crown of the pipe is retained. Use T pieces with branches at 45^{o} in direction of flow.
- Joints
  - Ensure joints are capable of resisting longitudinal forces without sliding apart.
  - Ensure joints are restrained to prevent relative movement.
- Jointing
  - Make joints in accordance with manufacturer's recommendations
- Outlets
  - Ensure that outlets are fixed before connecting pipework. Position outlets to align with high level collection pipes. Connect the outlet spigot to the pipework in accordance with manufacturer's instructions using a proprietary connection.

320.110 PIPEWORK INSTALLATION:

- Fix high level collector pipes and downpipes in accordance with manufacturer's recommendations.
- Install polyethylene pipework using rail system to constrain thermal movement.
- Support horizontal or near-horizontal sections of rainwater outlet tail pipe greater than 1.5 metres long.
- Use additional supports on pipe collars, particularly at changes in direction.
- Do not make changes in direction in pipe runs unless they are shown on the drawing or otherwise approved.
- Provide rodding eyes as indicated.
- Ensure all pipe hangers, beam clamps, bolts, nuts and fittings used in the pipe support system are either hot dip galvanised or bright zinc phosphate finish. Fit an isolation strip within all supports to separate dissimilar metals.

320.120 TESTING:

- Inform CA in advance to give a reasonable opportunity to observe tests.
- Check all sections of installation are free from obstruction and debris before testing.
- Provide assistance and apparatus for testing.
- Carry out tests in accordance with BS EN 12056.
  - Air test
  - Water test
- Remedy all defects without delay and re-test as instructed.

R11 - FOUL DRAINAGE ABOVE GROUND

PART 3 SPECIFICATION CLAUSES SPECIFIC TO R11

300.000 GENERAL / PRODUCTS / MATERIALS

300.005 GENERAL:

- Install commission and set to work a gravity drainage system inside the building in accordance with BS EN 12056 as appropriate.

300.021 FLOOR DRAIN:

- Plastic floor drain FD-1
  - Standard
    - BS EN 1253
  - Material
    - [PVC
  - Outlet
    - Bottom
    - Side
  - Sediment Bucket
    - Required
  - Top or Strainer Material
    - Stainless steel
  - Top of Body and Strainer Finish
    - Stainless steel
  - Top Shape
    - linear as per sanitary manual
  - Trap Material
    - [Plastic drainage piping]
  - Trap Pattern
    - Standard P-trap

- Cast iron floor drain, FD-2
  - Standard
    - BS EN 1253
  - Pattern
    - Floor
    - Funnel floor
  - Body Material

- Gray iron

- Outlet
  - Bottom
- Backwater valve
  - Drain-outlet type
  - Integral, swing-check type
- Top or Strainer Material
  - Gray iron
- Top of Body and Strainer Finish
  - Nickel bronze
  - Polished bronze
  - Rough bronze
- Top Loading Classification
  - Heavy Duty
- Funnel
  - Required
- Trap Material
  - Bronze
  - Cast iron
- Trap Pattern
  - Standard P-trap
- Trap Features
  - Cleanout

300.022 CLEANOUT:

- Metal floor clean outs
  - BS EN 1253
- Type
  - Adjustable housing
  - Cast-iron soil pipe with cast-iron ferrule
  - heavy-duty, adjustable housing
  - threaded, adjustable housing
- Outlet
  - Bottom
- Body or Ferrule
  - Cast iron
- Outlet Connection
  - Inside calk

        - Spigot
        - Threaded.
    - Closure
        - cast-iron plug
        - plastic plug
    - Adjustable Housing Material
        - Cast iron
        - threads
        - set-screws or other device
    - Frame and Cover Material and Finish
        - Stainless steel
    - Top Loading Classification
        - Heavy
    - Housing
        - Stainless steel
    - Closure
        - Stainless steel with seal

- Plastic Floor Cleanouts
    - Standard
        - BS EN 1253
    - Body
        - PVC
    - Closure plug
        - PVC plug

300.023 TRENCH DRAIN:

- Metal trench Drain TD-1
    - Standard
        - BS EN 1253
    - Material
        - Ductile
        - Gray iron
    - Flange
        - Anchor
        - Seepage
    - Outlet
        - End
        - Side

- Grate Material
  - Ductile iron
  - Ductile iron or gray iron
- Top Loading Classification
  - Heavy Duty for waste rooms
- Trap Material
  - Same pipe material
- Trap Pattern
  - Standard P-trap

300.030 TRAPS:

- Form
  - P.
- Standard
  - Plastic to BS EN 274-1, BS EN 274-2, BS EN 274-3.
  - Cast iron
    - BS 416-1
    - BS EN 877

300.160 AIR ADMITTANCE VALVES:

- Standard - BS EN 12380
- Ensure that there is a change of gradient at stack connections. Use swept branches on small diameter pipes. Use swept inlet or 45° branch connections for pipe 75mm diameter or over.

300.161 VENT CAPS (VENT COWL):

- Material
  - uPVC Plastic Cowl conforming to BS EN 1329 and to BS 4514
- Size: Same as connected stack vent or vent stack.
- Install vent caps on each vent pipe passing through roof.

310.000 WORKMANSHIP

310.010 PERFORMANCE CRITERIA:

- Install pipework fittings and accessories to ensure that:
  - Appliances drain quickly, quietly and completely at all times without nuisance or risk to health.
  - Discharge is conveyed without crossflow, backfall, leakage or blockage.
  - Air from drainage system does not enter building.
  - Pressure fluctuations in pipework do not vary by more than plus or minus 38mm water gauge and traps retain a water seal of not less than 25mm.
  - System can be adequately tested, cleaned and maintained.

310.020 ROUTES:

- Ensure pipe routes are shortest practicable, with as few bends as possible and no bends in wet portion of soil stacks, unless indicated otherwise on drawings.

310.030 COATED PIPES:

- Make good damaged coatings and cut ends, or recoat, as recommended by manufacturer.

310.040 INSTALLATION GENERALLY:

- Install pipes, fittings and accessories in accordance with BS 8000-13, BS EN 12056-5 and manufacturer's recommendations.
- Install thermoplastic piping systems in accordance with PD CEN/TR 13801
- Obtain all components for each type of pipework from the same manufacturer, unless otherwise indicated.
- Inspect components carefully before fixing and reject any which are defective.
- Ensure cut ends of pipes to be clean and square with burrs removed.
- Allow for thermal and building movement when jointing and fixing.
- Form junctions using fittings intended for the purpose, ensuring that jointing material does not project into bore of pipes, fittings and appliances.
- Avoid contact between dissimilar metals and other materials which would result in electrolytic corrosion.
- Provide access covers and cleaning eyes as necessary in convenient locations, to permit adequate testing and cleaning of pipework.
- Prevent entry of foreign matter into any part of system by sealing openings during construction. Fit all access covers and cleaning eyes as work proceeds.

310.070 WASTES:

- Bed in waterproof jointing compound and fix with resilient washer between appliance and backnut.

310.080 WASTE CONNECTORS:

- Join to traps as manufacturer's recommendations.

310.100 TRAP TEST REQUIREMENTS:

- Ensure there is a retention of a minimum of 25mm water seal in every trap, and that no air is blown through the trap seal when performance is tested.

310.110 ACCESS POINTS:

- Provide rodding and access points at all changes of direction to enable whole system to be maintained.
- Provide square door type access points as indicated on drawings at foot of all soil and ventilation pipes and at any subsequent floor levels as indicated on the drawings and/or as directed by building control. Where practicable, locate access points and horizontal anti-syphon pipes above fitment flood level a minimum of 1200mm above the respective finished floor level.
- In general make WC connections to drain points and soil pipes via flexible connectors.

R12A - DRAINAGE BELOW GROUND - UTILITIES

PART 1 SYSTEM OBJECTIVES

100.000 OBJECTIVES

100.010 SUMMARY

A. This Section includes storm drainage outside the building.

110.000 DESIGN PARAMETERS

110.010 PROJECT/SITE CONDITIONS

A. Site Information: Perform site survey, research public utility records, and verify existing utility locations.

B. Locate existing structures and piping, if any, to be closed and abandoned.

C. Existing Utilities: Do not interrupt or interfere with utilities serving facilities on the Project site or on adjoining property unless permitted by the Engineer under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated or directed.

D. Notify the Engineer not less than 72 hours in advance of proposed utility interruptions.

E. Do not proceed with utility interruptions without the Engineer's written permission.

F. Coordinate connection to drainage main with concerned authorities

110.020 DEFINITIONS AND ABBREVIATIONS

A. The following are industry abbreviations for used materials:

1. PE: Polyethylene plastic.
2. uPVC: Unplasticized Polyvinyl chloride plastic.
3. GRP: Glass-Fiber Reinforced Plastic.
4. VC: Vitrified Clay.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. General

1. Drawings and general provisions of the Contract, including Conditions of Contract and Division A Specification Sections, apply to this Section.

B. Related Sections

1. Section D20 "Excavating and Filling" for excavating, trenching and backfilling.
2. Sections E05 "In Situ Concrete Construction Generally", E10 "Mixing, Casting and Curing In Situ Concrete", E20 "Formwork for In Situ Concrete" and E30 "Reinforcement for In Situ Concrete" for concrete structures.
3. Section J40 "Flexible Sheet Waterproofing and Damp Proofing".

PART 3 MATERIALS AND WORKMANSHIP

300.000 MATERIALS

300.010 PIPES, FITTINGS AND ACCESSORIES

A. CONCRETE PIPE

B. PIPES AND FITTINGS: THERMOPLASTIC PIPE

1. uPVC GRAVITY PIPE
2. POLYETHELENE (PE) GRAVITY PIPE
3. SUB-DRAIN TILE PIPE
    a) .
4. SUB-DRAIN PERFORATED PIPE

C. PIPES AND FITTINGS: GRP PIPE FOR DRAINAGE

D. PIPE ACCESSORIES: TAPPING SADDLES:

1. CAST IRON

E. SERVICE CONNECTIONS

1. This work shall consist of the provision and installation of the pipes from the manhole or main pipe up to the inspection or valve chamber or stubout to be located at the property line all as indicated on the Drawings.
2. Building or house connection can be single or grouped as indicated on the Drawings.
3. Unless otherwise indicated on drawings, the material of pipes and fittings for service connections shall be similar to those used for the secondary pipe and conforming to the requirements of this Section
4. Work on service connection shall be carried out as specified in sub-sections 330.000 below.

F. COMPRESSIBLE BOARD

1. CONSTRUCTION JOINT MATERIAL

300.020 VALVES

A. GATE VALVES

B. BUTTERFLY VALVES

C. CHECK VALVES

D. AIR VALVES

1. AIR VALVES FOR PRESSURIZED MAINS

300.030 VALVES: JOINTING MATERIALS

A. GENERAL

1. GASKETS:
2. RINGS:
3. BOLTS AND NUTS:
4. WASHERS:.
5. DIELECTRIC JOINTS:

300.040 VALVE ACCESSORIES AND OPERATORS

A. VALVE ACCESSORIES

1. HANDWHEELS
2. VALVE CAPS
3. OPERATION KEYSInsert rate, normally 1 in 5.
4. EXTENSION SPINDLES FOR GATE VALVES
5. PROTECTION TUBES:
6. SURFACE BOXES:
7. LIFTING KEY SETS
8. Operating Wrenches:

300.050 MANHOLES, GULLIES, INLETS, CHAMBERS AND INTERCEPTORS: COATINGS

A. COATING for internal surfaces of concrete manholes and chambers

B. COATING for external surfaces of concrete manholes and chambers

or other equal and approved.

C. WATERPROOFING external surfaces

300.060 MANHOLES & CHAMBERS: COMPONENTS

A. CAST IN SITU UNITS

B. PRECAST UNITS

C. BRICKS:

D. COVERS AND FRAMES:

1. For apron and graded area of the runway strips and taxiway strip (Taxiway and Shoulder): Class F900 ultra heavy-duty non-rock type for aircraft wheel loads. minimum test load 900 kN.
2. for Roadways: Class D400, Heavy duty, minimum test load 400 KN.
3. for sidewalks: Class C250, Medium duty, minimum test load 250 KN
4. for footpaths: Class B125, Light duty, minimum test load 125 KN.

E. Manhole Cover Inserts: Manufactured, GRP form, of size to fit between manhole frame and cover and designed to prevent stormwater inflow. Include handle for removal and gasket for gastight sealing.

1. Type: Solid.
2. Type: With drainage and vent holes.
3. Type: With valve.

F. ROAD GULLY GRATINGS: non-rocking to BS EN 124, coated to BS 3416. Minimum thickness 250 microns. Types to be as follows:

a) for Roadways: Class D400, Heavy duty, minimum test load 400 KN.
b) for sidewalks: Class C250, Medium duty, minimum test load 250 KN
c) for footpaths: Class B125, Light duty, minimum test load 125 KN.

G. GRP ladders:

H. SAFETY CHAINS:

I. GUARDRAILING:

J. GEOTEXTILE FILTER MEMBRANE

310.000 QUALITY MANAGEMENT

310.010 GENERAL REQUIREMENTS

1. MANUFACTURER'S CERTIFICATE: materials are to be supplied with a certificate, in respect of each delivery, stating that products comply with and have been factory tested in accordance with specified Standards.
2. MARKING: unless otherwise specified in the relevant Standard products are to have legibly cast, stamped or indelibly painted on, the following marks, as appropriate:

a) manufacturer's name, initials and identification mark
b) nominal diameter
c) class designation
d) initials and number of relevant Standard
e) length of pipe if shorter than standard length
f) angle of bends in degrees
g) date of manufacture.

3. SPECIAL TESTS: whenever required by the Engineer, supply and transport to a testing laboratory samples of materials selected by the Engineer. Number of samples is not to be more than 0.5% of total supplied, with at least one from each class, diameter and manufacturer.

Failure of any sample is to be followed by a second and if necessary a third test from the same batch. A third test failure will result in all material from that manufacturer being rejected and replaced by material from a different manufacturer, subject to approval and satisfactory tests. Provide laboratory test report in an approved form.

320.000 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for system materials and products.

B. Include plans, elevations, details, and attachments for the following:

1. Drainage pipe network, including pipe diameters and gradients
2. Manholes and other structures, including invert levels, frames, covers, and grates.

C. Coordination Drawings: Show manholes and other structures, pipe sizes, locations, and elevations. Include details of underground structures and connections. Show other piping in same trench and clearances from drainage system piping. Indicate interface and spatial relationship between piping and proximate structures.

D. Coordination Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1:1000 and vertical scale of not less than 1:100. Indicate underground structures and pipe. Show types, sizes, materials, and elevations of other utilities crossing system piping.

E. As-Built Drawings: At project close-out, submit record drawings of installed pipework and products, in accordance with requirements of the Specification, Division A.

F. Maintenance Data: Submit maintenance data and parts lists for system materials and products. Include this data, product data, Shop Drawings, and submit drawings in maintenance manual; in accordance with requirements of the Specification, Division A.

G. Certificate of Compliance.

H. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

330.000 EXECUTION

330.010 PIPES, FITTINGS AND ACCESSORIES

A. GENERAL

1. MANUFACTURER'S RECOMMENDATIONS on handling, repairing, laying, jointing, anchoring, testing and other works for pipes, fittings, valves and accessories are to be strictly followed.
2. LOADING AND UNLOADING: use cranes, hoists or skidways as directed by the Engineer. Use hooks, spreader beams, ropes, band or wire slings etc. as recommended by manufacturer for each type of pipe and as approved by the Engineer.
3. STACK pipes on level surface. Do not rest pipes on sockets or jointing fairlings. Securely chock end pipes in bottom row. Height of stack is to be to manufacturer's instructions.
4. HANDLE material with care to avoid damage whether moved by hand, skidways or hoists.
5. STORING: provide safe storage for material. Interior of pipes, fittings etc. are to be kept free from dirt and foreign matter. Provide shade for materials as required by manufacturer's instructions and to the Engineer's approval.
6. CUTTING: use hacksaws, manually operated wheel cutter or pipe cutting machine as per manufacturer's instructions. If, in the opinion of the Engineer, special precautions are to be taken to eliminate airborne particles, use methods and equipment as directed by the Engineer. Prepare ends according to type of joint used and follow manufacturer's recommendations. Take care not to damage lining, if any. Repair on site, minor damage, if permitted.
7. REPAIR DAMAGED COATING, SHEATHING OR LINING in accordance with the Specification and manufacturer's instructions. Use material compatible with that originally used. Repair is to be approved by the Engineer before incorporating materials into the work.

B. EXCAVATION AND EARTHWORK

1. EXCAVATION AND EARTHWORK including but not limited to pipe trenches, earthwork support, backfilling, disposal, and surface reinstatement are to be in accordance with the requirements of Division D20 of the Specification.

C. PIPE LAYING AND JOINTING

1. GENERAL

a) LOWERING: do not lower pipe into trench until pipe bed is brought to grade and approved.
b) LOWERING: use ropes, wire slings, band slings, spreader beams etc. as recommended by manufacturer for each type of pipe and as approved.
c) EXAMINE MATERIAL carefully for damage. Test for soundness in accordance with manufacturer's instructions before laying.
d) EXAMINE MATERIAL: ensure internal coating or lining and outer coating or sheathing are undamaged. If damaged, make good or dispose of as directed.
e) PIPE CLEANLINESS: remove dirt and foreign matter before lowering.
f) PIPE CLEANLINESS: clear construction debris from inside of pipe before making joint.
g) PIPE PLACEMENT: lay pipe on an even formation true to grade and line, with sockets (if any) facing up the gradient.
h) PIPE ON SOLID GROUND: cut holes in bottom of trench to allow proper jointing and for barrel of pipe to bear evenly on solid ground for its full length.
i) PIPE ON GRANULAR BEDDING: scoop out locally at sockets/couplings to enable pipe to rest uniformly on barrel and adjust to exact line and level. After testing lay and compact further granular material in 100 mm layers to levels shown on the Drawings.
j) PIPE ON CONCRETE BED OR SURROUND: provide rectangular blocks of concrete as per Section E10, made in approved moulds at least 14 days before use, and approved hardwood folding wedges. Provide two concrete blocks for each pipe, set and bone into correct level on formation bottom and lay pipe properly centred and socketed. Insert two hardwood folding wedges, of width equal to width of concrete block, between body of pipe and block and drive together until pipe is brought to exact level required. Leave blocks and wedges undisturbed while pipes are being jointed and concrete bed and haunch or surround are being placed. Ensure blocks and wedges are of sufficient size and strength to prevent settlement of pipes. Leave sufficient space to enable joints to be made, tested and inspected.
k) PIPE PLUGS: when pipe laying is not in progress, close open ends of pipes with properly fitted temporary wooden plugs or standard caps as directed.

2. JOINTING

a) MANUFACTURER'S INSTRUCTIONS are to be followed regarding cleanliness of joint surfaces, lubricant used, correct location of components, provision of correct gaps between end of spigot and back of socket for flexible joints etc.
b) DEFLECTION OF JOINT: do not deflect flexible joints beyond maximum permissible angles given by manufacturer and/or relevant Standard.
c) PATENT DETACHABLE AND FLEXIBLE JOINTS: strictly comply with special instructions issued by manufacturers of proprietary joints when laying and jointing.
d) DIFFERING PIPE AND FITTING MATERIAL: joint with adaptors as recommended by pipe manufacturer.
e) LINE AND GRADIENT

1) IN OPEN EXCAVATION: provide and maintain sight rails and boning rods properly painted to ensure correct alignment of pipe runs. Sight rails are to be positioned either vertically above the lines of pipes or immediately adjacent thereto. At no time are there to be less than three sight rails in position on each length of pipeline under construction to any one gradient.
2) IN HEADING: provide and maintain marks to establish line and level of pipeline. Marks are to be fixed in each working shaft and two further marks established in each length of heading.

3. TOLERANCES

a) GRAVITY PIPES

4.

a) PREVENTION
b) REMOVE

5. PIPES BUILT INTO STRUCTURES

a) TREATMENT OF EXTERNAL SURFACE
b) FLEXIBLE JOINTS

D. IDENTIFICATION:

1. Use warning tape or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

E. FIELD TESTING

1. GENERAL

a) PROVIDE pumping equipment, pressure gauges, instruments and water needed for hydrostatic testing.
b) CARRY OUT TESTS in the presence of the Engineer.
c) FITTINGS AND JOINTS: permanently anchor fittings before testing and leave all joints exposed for checking.
d) TEST SECTIONS: limit test sections to not more than 500 m.
e) TEST SECTIONS: test pressure lines between valve chambers whenever possible.
f) TEST SECTIONS: test gravity sewers in sections between manholes.
g) TEST PLUG: secure end of main and test plug by struts.
h) CLOSED VALVE: do not test against a closed valve unless there is no acceptable alternative.
i) APPLY PRESSURE by manually operated test pump or, in the case of large diameter mains, by power driven test pump, if approved.
j) EXAMINE exposed joints and repair visible leaks.
k) FAILURE: should a test fail, locate leak and replace or make good defective pipe or replace and make good faulty joint. Retest main.
l) RECORDS: keep test records in an approved form. Hand original copy to the Engineer immediately after completion of test.
m) PRESSURE LINES: carry out hydrostatic test while pipeline is partially backfilled.
n) NON-PRESSURE LINES not exceeding 900 mm diameter are to be air tested before backfilling and hydrostatic tested after backfilling.
o) NON-PRESSURE LINES over 1000 mm diameter are to be visually inspected from the inside and tested at joints by hydraulic individual joint test.
p) NON-PRESSURE LINES: Carry out infiltration tests where crown of pipe at high part of length under test is more than 1.2 m below water table.

2. HYDROSTATIC TESTING OF PRESSURE PIPELINES

a) FILL PIPE slowly with water from lowest point. Do not use power-driven pump unless approved.
b) FILL ABSORBANT PIPES with water and allow to stand for at least 24 hours to allow complete absorption.
c) ENTRAPPED AIR is to be bled before pressurizing.
d) PRESSURIZING is to continue until specified test pressure is reached in lowest part of section under test. Bleed further quantities of entrapped air while raising pressure.
e) MAINTAIN TEST PRESSURE for specified test duration with pumping stopped.
f) REPRESSURIZE to original test pressure and record respective volumes of water pumped.
g) FAILURE: pipeline will be deemed to have failed test if:

1) visible leaks are detected, regardless of leakage being within specified limits.
2) volume of water lost during period when pumping was stopped exceeds allowable leakage.

h) TEST PRESSURE: Unless otherwise specified, the test pressure shall be equal to 1.5 times the maximum working pressure of the pipeline as shown on the Drawings or as determined by the Engineer on Site, but shall in no case exceed 75% of the factory hydrostatic test pressure.

i) TEST PERIOD: 2 hrs.

j) ALLOWABLE LEAKAGE: 0.02 liters/mm dia/km length/day/10 m head of applied pressure.

3. HYDROSTATIC TESTING OF NON-PRESSURE PIPELINES

a) PROCEDURE is to be as described for pressure pipes.
b) TEST PRESSURE: 1.0 m head of water above pipe soffit at highest point and not greater than 6 m head of water at lowest point of section under test. If maximum head is exceeded, test section in stages.
c) TEST PERIOD: 1 hour.
d) ALLOWABLE LEAKAGE FOR PIPELINES: 0.12 litres/km length metre/metre diameter/hr.
e) ALLOWABLE LEAKAGE FOR PIPELINES INCLUDING STRUCTURES OR FOR STRUCTURES ALONE: As specified in BS EN 1610.

4. Air Testing of Pipelines

a) Test procedure to BS EN 1610.

5. Infiltration Test for Gravity Pipes

a) Timing: Carry out test after total backfilling of length under test.
b) Plug effectively all inlets to system as directed.
c) Measure residual flow by approved method i.e. weir or other.
d) Infiltration limits: The following limits are not to be exceeded:

1) Pipelines not exceeding 700 mm: 0.02 litres/hour/100 linear metres/mm diameter,
2) Pipelines over 700 mm: 0.03 litres/hour/100 linear metres/mm diameter.

e) Failure: Test will be deemed to have failed if allowable infiltration water is exceeded. Locate source of excessive infiltration by approved means i.e. traversing light and mirrors or inflated rubber plug etc. and make good. Repeat test until successful.

6. VISUAL INSPECTION TEST

a) TIMING: carry out test after total backfilling of length under test.
b) LIMIT of length to be tested at one time is three full-length pipes unless otherwise approved.
c) APPARATUS: use rubber tired bogies which do not damage lining of pipe and an adequate supply of electric lamps.
d) CHECK joints by means of feelers to ensure rubber rings are correctly located.
e) CHECK pipe barrel for visible cracks.

7. Hydraulic Individual Joint Test for Pipes Exceeding 1000 mm:

a) Test Procedure to BS EN 1610

8. DEFLECTION TESTS FOR GRP PIPES

a) CONDUCT: deflection tests for GRP pipes as required by the Engineer at 3 stages. Deflection shall be measured at the spigot end at midpoint and at socket end.
b) STAGE 1: at completion of primary backfill (deflection at this stage should be below 0.5%).
c) STAGE 2: at final backfill (Maximum allowable deflection 2.5%).
d) STAGE 3: six months after final backfill (maximum allowable deflection 4.0%).
e) PIPES not passing the deflection tests at stage 2 or stage 3 will be removed and replaced.

F. BUILDING CONNECTIONS

1. Location: The Contractor shall agree location and invert level of connections with the Engineer before starting construction.

2. The Contractor shall programme connections to follow closely construction of sewer.
3. Execution: Connection to sewer shall be at manhole, where possible, or by T or Y junction subject to the Client approval.
4. Minimum Grade: The Contractor shall lay connections at minimum grade of 0.75 per 1000 unless otherwise approved.
5. The Contractor shall install, bed and test connections in same manner as main sewers.
6. Records: The Contractor shall maintain accurate records of location of connection to main drainage pipe.

    a) Location, description and elevation of obstructions and method of protection.

7. Survey Log Book: The Contractor shall keep records in an approved survey log book, made available for inspection and handed to the Employer on completion. The Contractor shall transfer information to sketches and tables as agreed with the Engineer, provide three bound copies and hand to the Employer.

G. CLEANING AND INSPECTION OF DRAINAGE NETWORKS

1. CLEANING: clean pipeline of silt and debris after backfilling pipe trenches and completing manholes, hatch boxes etc. but before surfaces are permanently reinstated and make ready for inspection by the Engineer.
2. INSPECTION: pipelines of 900 mm diameter and over are, where practicable, to be inspected from the inside and when necessary a suitable trolley is to be provided for this purpose.
3. INSPECTION: pipelines less than 900 mm diameter and larger pipelines which cannot be inspected from the inside, are to be inspected by passing a cylinder of diameter 25 mm less than the internal diameter of the pipe and length not less than the internal diameter of the pipe through each pipeline.

H. BEDDING, HAUNCHING, ENCASEMENT AND THRUST BLOCKS

1. GENERAL

    a) CONCRETE WORK generally is to comply with the appropriate requirements of Sections E05 "In Situ Concrete Construction Generally", E10 and "Mixing, Casting and Curing In Situ Concrete", E20 "Formwork for In Situ Concrete" and E30 "Reinforcement for In Situ Concrete".

2. PLACING CONCRETE

    a) AFTER PLACING PIPE place concrete in trench and thoroughly work under pipe to provide solid and uniform bedding.
    b) AFTER PIPE JOINT IS COMPLETED place balance of concrete or haunching and work into place on both sides simultaneously.
    c) FORM VERTICAL CONSTRUCTION JOINTS in concrete beds, surrounds etc. at face of pipe joints with compressible board and finish to profile of concrete and pipe. Fill any gap between spigot and socket with approved resilient material.

3. PLACING MATERIAL OTHER THAN CONCRETE

    a) PLACE BEDDING MATERIAL in bottom of prepared trench and carefully hand tamp to minimum thicknesses.
    b) AFTER PIPE HAS BEEN LAID, place additional material or haunching in successive layers not exceeding 150 mm thick on both sides simultaneously. Completely fill spaces between pipe and side of trench and carefully hand tamp without disturbing pipe.

4. THRUST BLOCKS

    a) GENERAL: provide thrust blocks at bends and junctions on pressure pipelines. Additional excavation required is to be made after pipeline has been jointed. No pressure is to be applied to the thrust block until concrete has matured for at least 3 days.

330.020 VALVES & ACCESSORIES

A. GENERAL

1. PRIOR TO INSTALLATION, inspect for cleanliness of bores, seating surfaces etc. and for handling damage, cracks, missing parts and tightness of pressure-containing bolting.
2. ENSURE valves, gates and hydrants are in closed position before installation.
3. OPERATE valves and hydrants through one complete opening and closing cycle in the position in which they are to be installed to ensure proper functioning.

B. INSTALLATION

1. VALVES

a) SET AND JOINT valves to pipe in manner specified for laying and jointing pipe and/or to manufacturer's instructions.
b) CONCRETE PADS: provide valves with concrete pads, as specified in Section E10 and as shown on the Drawings so that pipe does not support weight of valve.
c) VALVES WITHOUT CONCRETE PADS: place on firm footing to prevent settling and excessive strain on connection to pipe.
d) DO NOT use valve to bring misaligned pipe into alignment during installation.
e) INSPECT all pressure-containing bolting (bonnet, seal plate and end connections) for adequate tightness after installation but prior to field testing.

C. FIELD PROTECTION

1. VALVES: protect valves against action of external agents by a coat of approved bituminous compound applied cold by brush after pressure tests on pipelines have been completed.
2. GATES: protect against action of external agents with one coat of approved bituminous compound applied cold by brush after installation.
3. BOLTS: protect buried bolts against corrosion with approved paint or by polyethylene wrapping.

330.030 MANHOLES & CHAMBERS

A. GENERAL

1. EXCAVATION AND BACKFILLING generally are to comply with the appropriate requirements of Division D20 of the Specification.

a) CONCRETE WORK generally is to comply with the appropriate requirements of Sections E05 "In Situ Concrete Construction Generally", E10 and “Mixing, Casting and Curing In Situ Concrete”, E20 "Formwork for In Situ Concrete" and E30 "Reinforcement for In Situ Concrete".

B. MANHOLES AND INSPECTION CHAMBERS

1. PRECAST UNITS: if used, shall have been cast at least 3 weeks before sections are used. Bed lowest unit on in situ concrete base and bed and haunch in cement mortar. Liberally coat joints of units with approved bituminous material of troweling grade prior to fixing. Ensure joints are filled solid and neatly strike off surplus compound. Do not disturb work for 7 days thereafter. Alternatively seal joints with approved preformed jointing strip in accordance with manufacturer's instructions. Bed precast concrete cover slab on top unit in cement mortar.
2. CHANNELS in bottom of manhole are to be smooth, semi- circular and size equal to diameter of adjacent sewers. For straight through manholes, construct channels of half pipe sections. Make changes in direction of flow with smooth curves as large as manholes permit. Changes in size and grade of channels are to be gradual and even.
3. BENCHING: form in sulphate resisting concrete, as specified in Section E10, to rise vertically from top of channels to a height not less than soffit of outlet pipe, then slope upwards 1 in 10 to walls. Within 3 hours, float with coat of sulphate resisting cement-sand mortar 1:2 and finish smooth with steel trowel.
4. EXTERNAL COATING: cover faces of manholes and chambers with three coats applied by brush in accordance with manufacturer's instructions.
5. INTERNAL COATING: cover faces of manholes and chambers with four coats applied by brush in accordance with manufacturer's instructions.
6. ADJUSTMENT FOR LEVEL: build top courses of brickwork or blockwork after completion of surrounding levels. Adjust as necessary to give accurate and even final levels.

7. COVERS AND GRATINGS: bed frame solidly in mortar with cover in position to prevent twisting. Position centrally over opening and level and square with surrounding finishes.
8. TESTING OF MANHOLES: plug manhole inlets and outlets, fill manhole with water and allow to stand for at least 24 hours or such longer period to allow for complete absorption. Re-top with water. Allowable leakage over 24 hours is not to exceed 1% of total volume of manhole, otherwise make good and retest.

C. VALVE CHAMBERS

1. CONSTRUCTION: to be in situ concrete, precast concrete or blockwork as shown on the Drawings.
2. EXTERNAL COATING: cover faces of chambers with two to three coats applied by brush in accordance with manufacturer's instructions.
3. COVERS: bed frame solidly in mortar with cover in position to prevent twisting. Position centrally over opening and level and square with surrounding finishes.

R12B - DRAINAGE BELOW GROUND

PART 3 SPECIFICATION CLAUSES SPECIFIC TO R12

300.000 GENERAL

300.010 GENERAL:

- Install, commission and set to work a below ground gravity drainage system
    - Inside the building the system shall be in accordance with BS EN 12056 as appropriate.
    - Outside buildings the system shall be in accordance with BS EN 752
- Include all civil works.

300.030 LOCATION OF EXISTING DRAINS:

- Prior to commencement, confirm invert levels and positions of existing drains, sewers and inspection chambers against information shown on drawings and report discrepancies.
- Protect existing drains and maintain normal operation during construction.

300.040 CONDITION OF EXISTING DRAINS

- Test existing drainage to establish condition.

310.052 METAL BANDED FLEXIBLE COUPLINGS ADAPTORS AND BUSHES:

- Type
    - Flexible coupling without shear band.
    - Flexible coupling with shear band.
    - Flexible adaptor for use with pipes of different outside diameter.
- Application
    - Connecting pipes of different materials
    - Connecting pipes of different diameter
    - Jointing short / cut lengths of pipe
    - Jointing post-inserted performed junctions
- Standard - BS EN 16397-1 and BS EN 16397-2
- Materials
    - Sleeve - rubber to BS EN 681-1
    - Clamping bands
        - 316 stainless steel.

310.100 WORKMANSHIP

- Pipes and fittings of common type to be procured from same manufacturer. Joint pipes and fittings with adaptors as recommended by particular manufacturer.

- Lay pipes to line and even gradient and on even bed for full length of the pipe with any sockets facing towards direction of flow.
- Use recommended lubricants for joints. Leave recommended gaps at end of spigots to allow for movement.
- Protect pipelines from ingress of debris. Seal all exposed ends of pipes during construction.
- Minimise time between laying and testing. Backfill after successful testing.

310.110 PIPES PASSING THROUGH STRUCTURES

- Provide short length (or rocker pipe) near external face where it is necessary to cast in or fix pipes to structures (including inspection chambers and catch pits). Install flexible joint at each end.

Pipe Size (DN)	Distance to first joint from structure (mm)	Short Length (mm)
100 X 150	150	600
225	225	600

- Where it is not necessary to cast in or fix pipes to structures (e.g. walls to footings) provide
- Short length or rocker pipes as above.
- Openings in the structure: ensure 50mm minimum clearance all round pipe: closely fit a rigid sheet to each side of the opening, preventing ingress of soil or vermin.

330.000 FITTINGS, TERMINALS, ACCESSORIES

330.010 GENERAL:

- Ensure each complete assembly of fittings, traps, etc., including appropriate couplings, is procured from a common manufacturer. Check compatibility components with each other and with the pipe system.

330.030 CONNECTORS:

- Kitemark Compliant.
- CE certified.

330.040 GREASE TRAPS (GREASE INTERCEPTOR):

- Standard
  - BS EN 1825-2.
  - Kitemark Compliant.
  - CE certified.
- Body Material:
  - Cast iron
  - Cast iron or steel
- Interior Lining:
  - Corrosion-resistant enamel
- Exterior Coating:

- Corrosion-resistant enamel

- End Connections
  - Flanged
  - Hub
  - Threaded
- Clean out
  - Integral
  - Field installed on outlet
- Mounting:
  - Recessed, flush with floor
- Operation:
  - Manual cleaning
  -

330.041 LINT INTERCEPTOR:

- Standard
  - Kitemark Compliant.
  - CE certified.
- Factory-fabricated interceptor made for removing and retaining lint
- Body Material:
  - Cast iron
  - Stainless steel
- Interior Separation Device
  - Baffles
  - Screens
- Interior Lining:
  - Corrosion-resistant enamel
- Exterior Coating:
  - Corrosion-resistant enamel
- End Connections
  - Threaded.
- Mounting:
  - Inline

330.050 SADDLE CONNECTORS:

- Kitemark Compliant.
- CE certified.

330.060 AIR RELEASE VALVES TO PRESSURE PIPES:

- Application: Forced main pipes.
- Install where shown on drawings at highest points.

330.070 WASH-OUT VALVES TO PRESSURE PIPES:

- Install at lowest points.

330.080 ANCHORS TO PRESSURE PIPES:

- Install anchors
- Horizontal thrusts
    - Cast cradle around half of pipe up to undisturbed trench side.
- Vertical or inclined thrusts
    - Clamp pipe/fitting to concrete block under with two 6 mm galvanized steel straps.
- Pipe inclines in excess of 16.5%
    - Cast concrete blocks across pipe and set into undisturbed ground.

330.090 FLEXIBLE COUPLINGS:

- Standard
    - BS EN 295-4
    - WIS 4-41-01.
- Ensure that the ends of pipes are cleanly cut, square, with clean and smooth outer surfaces prior to jointing.
- On concrete or iron pipes, smooth out mould lines.
- Apply a cement grout over the sealing area.

330.100 PRIVATE SEWAGE PACKAGED PUMPING STATION (SEWAGE SUMP PUMP):

- Type
    - Wet-Pit-Mounted, Quick-disconnect-system, submersible sewage pumps, grinder sewage pumps
- Application [sewage pumps for the building sanitary drainage systems
- Kitemark Compliant.
- CE certified.
- Factory-assembled and tested
- Motor:
    - Manufacturer's standard construction
    - Permanently sealed, oil-filled, and watertight
- Bolts, nuts and washers: Stainless Steel
- Pump shaft: corrosion-resistant steel
- Pump Arrangement

- Duplex

- Liquid-Level Control
  - Electrical and mechanical devices. (For duplex unit)
- Finish: Manufacturer's standard paint applied
- Casing:
  - Cast iron, with open inlet
  - Cast iron, with cast-iron legs
- Impeller
  - Statically and dynamically balanced
  - Impeller material
    - Cast bronze
    - Abrasion-resistant cast iron
    - Stainless Steel
- Control panel
    - Mounting
      - External, free-standing.
    - IP rating
      - IP54
- Controller interface
  - On-off status of each pump.
  - Alarm status.
- Cable ducts
  - Install cable ways for control panel supply and from control panel to tank, complete with draw wires.
  - Black PVC-U to BS 3506
  - Black PVC-U, Class B, to BS 4660
- Commission system, inspect and check the entire installation.

340.000 WORKMANSHIP FOR FITTINGS, TERMINALS, ACCESSORIES:

340.010 INSTALLATION OF FITTINGS:

- Fittings must be square and tightly jointed. Align with building constructions. Request instructions where doubt prevails.
- Allowable deviation in level of gully gratings +0 to -10mm.
- Cover exposed ends with purpose made caps. Protect from site traffic.

340.020 BENDS AT BASE OF SOIL STACK:

- Use a 90.5^{o} nominal rest bend with a minimum radius of 200mm to centreline of the pipe.
- Form with two 45^{o} bends with a minimum radius of 200mm to centreline of the pipe.
- Ensure pipe is not less than the following depth.
- Up to building height of 3 storeys: distance below lowest branch 450mm.

340.030 DIRECT CONNECTION OF GROUND FLOOR WCS:

- Drop from crown of WC trap to invert of drain not to exceed 1.5m.
- Horizontal distance from drop to ventilated drain not to exceed 6m.

340.040 INSTALLATION OF DRAINAGE CHANNELS:

- Install drainage channels in accordance with the manufacturers recommendations.

350.000 INSPECTION CHAMBERS/ACCESS/TANKS/SOAKAWAYS:

350.040 CONCRETE INSPECTION CHAMBERS:

- Kitemark Compliant.
- CE certified.
- Base
    - In situ concrete, mix as clause as per structural specifications
    - Thickness **[...]**
- Inspection chamber
    - To BS 5911-4 and BS EN 1917 all components from same manufacturer.
    - Cement type
        - Class 42.5 to BS EN 197-1
    - Chamber sections
        - Rectangular.
- Shaft sections - as chamber sections.
- Cover slabs
    - Square, 50mm thick.
- Joints
    - Bituminous sealing strip.
    - Cement mortar.
    - As recommended by inspection chamber manufacturer.
- In situ concrete surround
    - Not required.
    - 150mm minimum thickness, mix as clause as per structural speciications
- Access covers and seating to be cast iron.

350.150 PETROL INTERCEPTOR UNIT / OIL INTERCEPTOR:

- Type: Factory-fabricated interceptor for separating and removing of oil
- Kitemark Compliant.
- CE certified.
- Oil Type
    - Generator diesel and lubricating oil.
- Vent pipes

- Manifolded above ground, terminating at least 2.4m above ground level.
- Material
    - PVC-U
- Body Material:
    - Cast iron
- Interior Lining:
    - Corrosion-resistant enamel
- Exterior Coating:
    - Corrosion-resistant enamel
- End Connections
    - Suitable to connect to PVC-U piping.
- Clean out
    - Integral
- Mounting:
    - Recessed, flush with floor

350.180 CAST IRON ACCESS COVERS AND SEATING TO BS EN 124:

- Standard - Grey iron or ductile iron to relevant parts of BS EN 124
- Type
    - Class reference
        - B125, for light traffic use.
    - Size
        - 600mm x 450mm.
    - Duty
        - Heavy.
- Seating
    - Make-up in engineering bricks to BS EN 772-3 and BS EN 772-7 Class B, laid in 1:3 cement:sand mortar, or precast concrete cover frame units, Type 1 or Type 2 to suit cover shape.
    - Bed and haunch frame solidly in 1:3 cement:sand mortar over entire area, centrally over opening, level and square with joints in surrounding finishes. Cut back top of haunching to 30mm below top of surface material.

350.210 LIFTING KEYS:

- Provide lifting keys for each type of access cover and hand over at Practical Completion.

360.000 CLEANING/TESTING/INSPECTION

360.030 WATER/AIR TESTING OF GRAVITY DRAINS AND PRIVATE SEWERS UP TO DN 300:

- Immediately after completion of bedding/surround, air test short lengths of pipe to BS EN 752 all pipes from terminals and connections to inspection chambers and between inspection chambers.

360.070 WATER TESTING OF PRIVATE PRESSURE PIPELINES:

- Test pipes to BS EN 752 and following paragraphs. Test to be undertaken within 24 hours of completions of joints and installation of anchors.
- Commission pumping system, and check operation of complete installation is correct under normal working conditions.

R15 - SANITARY SEWERAGE

PART 1 SYSTEM OBJECTIVES

100.000 OBJECTIVES

100.010 SUMMARY

A. This Section includes sanitary sewerage outside the building

110.000 DESIGN PARAMETERS

110.010 PROJECT/SITE CONDITIONS

A. Site Information: Perform site survey, research public utility records, and verify existing utility locations.

B. Locate existing structures and piping, if any, to be closed and abandoned.

C. Existing Utilities: Do not interrupt or interfere with utilities serving facilities on the Project site or on adjoining property unless permitted by the Engineer under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated or directed:

D. Notify the Engineer not less than 72 hours in advance of proposed utility interruptions.

E. Do not proceed with utility interruptions without the Engineer's written permission.

F. Coordinate connection to sewer main with concerned authorities.

110.020 DEFINITIONS AND ABBREVIATIONS

A. The following are industry abbreviations for pipe materials:

1. PE: Polyethylene plastic.
2. uPVC: Unplasticized Polyvinyl chloride plastic.
3. GRP: Glass-Fiber Reinforced Plastic

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. General

1. Drawings and general provisions of the Contract, including Conditions of Contract and Division A Specification Sections, apply to this Section.

B. Related Sections

1. Section D20 "Excavating and Filling “for excavating, trenching and backfilling.
2. Section R16 "Utility Septic Tanks" for septic tank system structures and piping.
3. Sections E05 "In Situ Concrete Construction Generally", E10 and "Mixing, Casting and Curing In Situ Concrete", E20 "Formwork for In Situ Concrete" and E30 "Reinforcement for In Situ Concrete" for concrete structures.
4. Section J40 "Flexible Sheet Waterproofing and Damp Proofing".

PART 3 MATERIALS AND WORKMANSHIP

300.000 MATERIALS

300.010 PIPES, FITTINGS AND ACCESSORIES

A. PIPES AND FITTINGS: CONCRETE PIPE

1. GRAVITY PIPE

B. PIPES AND FITTINGS: THERMOPLASTIC PIPE

1. uPVC GRAVITY PIPE
2. uPVC PRESSURE PIPE
3. POLYETHELENE (PE) PRESSURE PIPE
4. POLYETHELENE (PE) GRAVITY PIPE

.

C. PIPES AND FITTINGS: GRP PIPE FOR SEWERAGE

1. TESTING ON GRP PIPES

a) Short-term hydraulic failure strength: to ASTM D1599.

D. PIPE ACCESSORIES: TAPPING SADDLES:

1. CAST IRON

E. SERVICE CONNECTIONS

F. COMPRESSIBLE BOARD

G. FILLING MATERIALS UNDER AND AROUND PIPES

300.020 VALVES

A. GATE VALVES

B. BUTTERFLY VALVES

C. CHECK VALVES

D. AIR VALVES FOR PRESSURIZED SEWAGE MAINS

1. GENERAL
2. SINGLE AIR VALVES
3. DOUBLE AIR VALVES (OR COMBINATION AIR VALVES)

300.030 VALVES: JOINTING MATERIALS

A. GENERAL

1. GASKETS
2. RINGS
3. BOLTS AND NUTS
4. WASHERS
5. DIELECTRIC JOINTS

B. FLEXIBLE COUPLINGS

C. DISMANTLING COUPLINGS

300.040 VALVE ACCESSORIES AND OPERATORS

A. VALVE ACCESSORIES

1. HANDWHEELS
2. VALVE CAPS:
3. EXTENSION SPINDLES FOR GATE VALVES:
4. PROTECTION TUBES
5. SURFACE BOXES:
6. LIFTING KEY SETS:
7. Operating Wrenches:

300.050 MANHOLES & CHAMBERS: COATINGS

A. COATING for internal surfaces of concrete manholes and chambers:

1. Four coats of solvent free 100% solid content polyamine based pure Epoxy 300mm thick and primer. or
2. GRP liners to the approval of the Engineer
3. or other equal and approved.

B. COATING for external surfaces of concrete manholes and chambers: 600 microns minimum thickness of asphaltic composition.

or other equal and approved.

C. WATERPROOFING external surfaces

1. Waterproofing for external surfaces shall be sheet tanking membrane with protective board as specified in Division J and other related sections.
2. Apply APP-Modified Bituminous sheet, single-ply, smooth surfaced, polyester reinforced, with according to ASTM D 5147

300.060 MANHOLES & CHAMBERS: COMPONENTS

A. CAST IN SITU UNITS

B. PRECAST UNITS.

C. BRICKS

D. COVERS AND FRAMES: to BS EN 124, coated to BS 3416 minimum thickness 250 microns, non-rocking, locking, solid top of circular pattern unless otherwise indicated on Drawings. Wording on cover to indicate type of network, approved on Site. Frames to be bolted to manhole to ensure proper fixity. Grades to be as follows:

1. For apron and graded area of the runway strips and taxiway strip (Taxiway and Shoulder): Class F900 ultra heavy-duty non-rock type for aircraft wheel loads. minimum test load 900 kN.
2. for Roadways: Class D400, Heavy duty, minimum test load 400 KN.
3. for sidewalks: Class C250, Medium duty, minimum test load 250 KN
4. for footpaths: Class B125, Light duty, minimum test load 125 KN.

E. Manhole Cover Inserts: Manufactured, GRP form, of size to fit between manhole frame and cover and designed to prevent stormwater inflow. Include handle for removal and gasket for gastight sealing.

1. Type: Solid.
2. Type: With drainage and vent holes.
3. Type: With valve.

F. GRP ladders: .

G. SAFETY CHAINS:

H. GUARDRAILING

310.000 QUALITY MANAGEMENT

310.010 GENERAL REQUIREMENTS

1. MANUFACTURER'S CERTIFICATE: materials are to be supplied with a certificate, in respect of each delivery, stating that products comply with and have been factory tested in accordance with specified Standards.
2. MARKING: unless otherwise specified in the relevant Standard products are to have legibly cast, stamped or indelibly painted on, the following marks, as appropriate:

a) manufacturer's name, initials and identification mark
b) nominal diameter
c) class designation
d) initials and number of relevant Standard

e) length of pipe if shorter than standard length
f) angle of bends in degrees
g) date of manufacture.

3. SPECIAL TESTS: whenever required by the Engineer, supply and transport to a testing laboratory samples of materials selected by the Engineer. Number of samples is not to be more than 0.5% of total supplied, with at least one from each class, diameter and manufacturer. Failure of any sample is to be followed by a second and if necessary a third test from the same batch. A third test failure will result in all material from that manufacturer being rejected and replaced by material from a different manufacturer, subject to approval and satisfactory tests. Provide laboratory test report in an approved form.

320.000 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for system materials and products.

B. Include plans, elevations, details, and attachments for the following:

1. Sewage pipe network, including pipe diameters and gradients
2. Manholes and other structures, including invert levels, frames, covers, and grates.

C. Coordination Drawings: Show manholes and other structures, pipe sizes, locations, and elevations. Include details of underground structures and connections. Show other piping in same trench and clearances from sewerage system piping. Indicate interface and spatial relationship between piping and proximate structures.

D. Coordination Profile Drawings: Show system piping in elevation. Draw profiles at horizontal scale of not less than 1:1000 and vertical scale of not less than 1:100. Indicate underground structures and pipe. Show types, sizes, materials, and elevations of other utilities crossing system piping.

E. As-Built Drawings: At project close-out, submit record drawings of installed pipework and products, in accordance with requirements of the Specification, Division A.

F. Maintenance Data: Submit maintenance data and parts lists for system materials and products. Include this data, product data, Shop Drawings, and submit drawings in maintenance manual; in accordance with requirements of the Specification, Division A.

G. Certificate of Compliance.

H. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

330.000 EXECUTION

330.010 PIPES, FITTINGS & ACCESSORIES

A. GENERAL

1. MANUFACTURER'S RECOMMENDATIONS on handling, repairing, laying, jointing, anchoring, testing and other works for pipes, fittings, valves and accessories are to be strictly followed.
2. LOADING AND UNLOADING: use cranes, hoists or skidways as directed by the Engineer. Use hooks, spreader beams, ropes, band or wire slings etc. as recommended by manufacturer for each type of pipe and as approved by the Engineer.
3. STACK pipes on level surface. Do not rest pipes on sockets or jointing fairlings. Securely chock end pipes in bottom row. Height of stack is to be to manufacturer's instructions.
4. HANDLE material with care to avoid damage whether moved by hand, skidways or hoists.
5. STORING: provide safe storage for material. Interior of pipes, fittings etc. are to be kept free from dirt and foreign matter. Provide shade for materials as required by manufacturer's instructions and to the Engineer's approval.
6. CUTTING: use hacksaws, manually operated wheel cutter or pipe cutting machine as per manufacturer's instructions. If, in the opinion of the Engineer, special precautions are to be taken to eliminate airborne particles, use methods and equipment as directed by the Engineer.

Prepare ends according to type of joint used and follow manufacturer's recommendations. Take care not to damage lining, if any. Repair on site, minor damage, if permitted.

7. REPAIR DAMAGED COATING, SHEATHING OR LINING in accordance with the Specification and manufacturer's instructions. Use material compatible with that originally used. Repair is to be approved by the Engineer before incorporating materials into the work.

B. EXCAVATION AND EARTHWORK

1. EXCAVATION AND EARTHWORK including but not limited to pipe trenches, earthwork support, backfilling, disposal, and surface reinstatement are to be in accordance with the requirements of Section D20 of the Specification.

C. PIPE LAYING AND JOINTING

1. GENERAL

a) LOWERING: do not lower pipe into trench until pipe bed is brought to grade and approved.
b) LOWERING: use ropes, wire slings, band slings, spreader beams etc. as recommended by manufacturer for each type of pipe and as approved.
c) EXAMINE MATERIAL carefully for damage. Test for soundness in accordance with manufacturer's instructions before laying.
d) EXAMINE MATERIAL: ensure internal coating or lining and outer coating or sheathing are undamaged. If damaged, make good or dispose of as directed.
e) PIPE CLEANLINESS: remove dirt and foreign matter before lowering.
f) PIPE CLEANLINESS: clear construction debris from inside of pipe before making joint.
g) PIPE PLACEMENT: lay pipe on an even formation true to grade and line, with sockets (if any) facing up the gradient.
h) PIPE ON SOLID GROUND: cut holes in bottom of trench to allow proper jointing and for barrel of pipe to bear evenly on solid ground for its full length.
i) PIPE ON GRANULAR BEDDING: scoop out locally at sockets/couplings to enable pipe to rest uniformly on barrel and adjust to exact line and level. After testing lay and compact further granular material in 100 mm layers to levels shown on the Drawings.
j) PIPE ON CONCRETE BED OR SURROUND: provide rectangular blocks of concrete, as per section E10, made in approved moulds at least 14 days before use, and approved hardwood folding wedges. Provide two concrete blocks for each pipe, set and bone into correct level on formation bottom and lay pipe properly centred and socketed. Insert two hardwood folding wedges, of width equal to width of concrete block, between body of pipe and block and drive together until pipe is brought to exact level required. Leave blocks and wedges undisturbed while pipes are being jointed and concrete bed and haunch or surround are being placed. Ensure blocks and wedges are of sufficient size and strength to prevent settlement of pipes. Leave sufficient space to enable joints to be made, tested and inspected.
k) PIPE PLUGS: when pipe laying is not in progress, close open ends of pipes with properly fitted temporary wooden plugs or standard caps as directed.

2. JOINTING

a) MANUFACTURER'S INSTRUCTIONS are to be followed regarding cleanliness of joint surfaces, lubricant used, correct location of components, provision of correct gaps between end of spigot and back of socket for flexible joints etc.
b) DEFLECTION OF JOINT: do not deflect flexible joints beyond maximum permissible angles given by manufacturer and/or relevant Standard.
c) PATENT DETACHABLE AND FLEXIBLE JOINTS: strictly comply with special instructions issued by manufacturers of proprietary joints when laying and jointing.
d) DIFFERING PIPE AND FITTING MATERIAL: joint with adaptors as recommended by pipe manufacturer.

3. LINE AND GRADIENT

a) IN OPEN EXCAVATION: provide and maintain sight rails and boning rods properly painted to ensure correct alignment of pipe runs. Sight rails are to be positioned either vertically above the lines of pipes or immediately adjacent thereto. At no time are there to

be less than three sight rails in position on each length of pipeline under construction to any one gradient.

b) IN HEADING: provide and maintain marks to establish line and level of pipeline. Marks are to be fixed in each working shaft and two further marks established in each length of heading.

4. TOLERANCES

a) GRAVITY SEWERS: tolerances are to be 6 mm in level and 25 mm in line between manholes or access points unless otherwise specified. Where pipe is to be constructed in straight lines between manholes or lampholes the length will not be accepted if a light at each manhole or lamphole cannot be seen from adjacent manholes.

5. FLOATATION

a) PREVENTION: whenever water is excluded from interior of pipe, place sufficient backfill above pipe to prevent floatation.

b) REMOVE any pipe that has floated, correct bedding and relay.

6. PIPES BUILT INTO STRUCTURES

a) TREATMENT OF EXTERNAL SURFACE: thoroughly clean outside surface of pipes to be built-in immediately before installation. Remove protective coating to metal pipes, where ordered. Roughen clay and concrete pipes as directed. Paint plastic pipes with appropriate solvent cement and sprinkle with dry coarse sand whilst wet. Cut away sheathing from sections to be built-in and after installation restore protection up to external face of structure with approved bituminous material.

b) FLEXIBLE JOINTS: provide two flexible joints or flexible patented joints adjacent to structures. Place first joint not more than one pipe diameter from face of structure and second not more than the following distances away from first:

1) pipelines not exceeding 450 mm: 2 pipe diameters.

D. IDENTIFICATION: Arrange for installing green warning tapes directly over piping and at outside edges of underground structures.

1. Use warning tape or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

E. FIELD TESTING

1. GENERAL

a) PROVIDE pumping equipment, pressure gauges, instruments and water needed for hydrostatic testing.

b) CARRY OUT TESTS in the presence of the Engineer.

c) FITTINGS AND JOINTS: permanently anchor fittings before testing and leave all joints exposed for checking.

d) TEST SECTIONS: limit test sections to not more than 500 m.

e) TEST SECTIONS: test pressure lines between valve chambers whenever possible.

f) TEST SECTIONS: test gravity sewers in sections between manholes.

g) TEST PLUG: secure end of main and test plug by struts.

h) CLOSED VALVE: do not test against a closed valve unless there is no acceptable alternative.

i) APPLY PRESSURE by manually operated test pump or, in the case of large diameter mains, by power driven test pump, if approved.

j) EXAMINE exposed joints and repair visible leaks.

k) FAILURE: should a test fail, locate leak and replace or make good defective pipe or replace and make good faulty joint. Retest main.

l) RECORDS: keep test records in an approved form. Hand original copy to the Engineer immediately after completion of test.

m) PRESSURE LINES: carry out hydrostatic test while pipeline is partially backfilled.

n) NON-PRESSURE LINES not exceeding 900 mm diameter are to be air tested before backfilling and hydrostatic tested after backfilling.

o) NON-PRESSURE LINES OVER 1000 mm diameter are to be visually inspected from the inside and tested at joints by hydraulic individual joint test.
p) NON-PRESSURE LINES: Carry out infiltration tests where crown of pipe at high part of length under test is more than 1.2 m below water table.

2. HYDROSTATIC TESTING OF PRESSURE PIPELINES

a) FILL PIPE slowly with water from lowest point. Do not use power-driven pump unless approved.
b) FILL ABSORBANT PIPES with water and allow to stand for at least 24 hours to allow complete absorption.
c) ENTRAPPED AIR is to be bled before pressurizing.
d) PRESSURIZING is to continue until specified test pressure is reached in lowest part of section under test. Bleed further quantities of entrapped air while raising pressure.
e) MAINTAIN TEST PRESSURE for specified test duration with pumping stopped.
f) REPRESSURIZE to original test pressure and record respective volumes of water pumped.
g) FAILURE: pipeline will be deemed to have failed test if:

1) visible leaks are detected, regardless of leakage being within specified limits
2) volume of water lost during period when pumping was stopped exceeds allowable leakage.

h) TEST PRESSURE: Unless otherwise specified, the test pressure shall be equal to 1.5 times the maximum working pressure of the pipeline as shown on the Drawings or as determined by the Engineer on Site, but shall in no case exceed 75% of the factory hydrostatic test pressure.

i) TEST PERIOD: 2 hrs.

j) ALLOWABLE LEAKAGE: 0.02 liters/mm dia/km length/day/10 m head of applied pressure.

3. HYDROSTATIC TESTING OF NON-PRESSURE PIPELINES

a) PROCEDURE is to be as described for pressure pipes.
b) TEST PRESSURE: 1.0 m head of water above pipe soffit at highest point and not greater than 6 m head of water at lowest point of section under test. If maximum head is exceeded, test section in stages.
c) TEST PERIOD: 1 hour.
d) ALLOWABLE LEAKAGE FOR PIPELINES: 0.12 litres/km length metre/metre diameter/hr.
e) ALLOWABLE LEAKAGE FOR PIPELINES INCLUDING STRUCTURES OR FOR STRUCTURES ALONE: As specified in BS EN 1610.

4. Air Testing of Pipelines

a) Test procedure to BS EN 1610.

5. Infiltration Test for Gravity Pipes

a) Timing: Carry out test after total backfilling of length under test.
b) Plug effectively all inlets to system as directed.
c) Measure residual flow by approved method i.e. weir or other.
d) Infiltration limits: The following limits are not to be exceeded:

1) Pipelines not exceeding 700 mm: 0.02 litres/hour/100 linear metres/mm diameter,
2) Pipelines over 700 mm: 0.03 litres/hour/100 linear metres/mm diameter.

e) Failure: Test will be deemed to have failed if allowable infiltration water is exceeded. Locate source of excessive infiltration by approved means i.e. traversing light and mirrors or inflated rubber plug etc. and make good. Repeat test until successful.

6. VISUAL INSPECTION TEST

a) TIMING: carry out test after total backfilling of length under test.
b) LIMIT of length to be tested at one time is three full-length pipes unless otherwise approved.

c) APPARATUS: use rubber tired bogies which do not damage lining of pipe and an adequate supply of electric lamps.
d) CHECK joints by means of feelers to ensure rubber rings are correctly located.
e) CHECK pipe barrel for visible cracks.

7. Hydraulic Individual Joint Test for Pipes Exceeding 1000 mm:

a) Test Procedure to BS EN 1610

8. DEFLECTION TESTS FOR GRP PIPES

a) CONDUCT: deflection tests for GRP pipes as required by the Engineer at 3 stages. Deflection shall be measured at the spigot end at mid point and at socket end.
b) STAGE 1: at completion of primary backfill (deflection at this stage should be below 0.5%).
c) STAGE 2: at final backfill (Maximum allowable deflection 2.5%).
d) STAGE 3: six months after final backfill (maximum allowable deflection 4.0%).
e) PIPES not passing the deflection tests at stage 2 or stage 3 will be removed and replaced.

F. SEWER BUILDING CONNECTIONS

1. Location: The Contractor shall agree location and invert level of connections with the Engineer before starting construction.
2. The Contractor shall programme connections to follow closely construction of sewer.
3. Execution: Connection to sewer shall be at manhole, where possible, or by T or Y junction subject to the Client approval.
4. Minimum Grade: The Contractor shall lay connections at minimum grade of 0.75 per 1000 unless otherwise approved.
5. The Contractor shall install, bed and test connections in same manner as main sewers.
6. Records: The Contractor shall maintain accurate records of location of connection to main sewer. Record details of the following:

a) Connection number.
b) Type of connection.
c) Diameter.
d) Downstream manhole number.
e) Distance from manhole.
f) Position (left or right) when facing upstream of street sewer.
g) Distance from centre line of sewer to end lateral.
h) Invert of street sewer.
i) Lateral invert at end point.
j) Number of inspection chambers.
k) Cover type.
l) Location, description and elevation of obstructions and method of protection.

7. Survey Log Book: The Contractor shall keep records in an approved survey log book, made available for inspection and handed to the Employer on completion. The Contractor shall transfer information to sketches and tables as agreed with the Engineer, provide three bound copies and hand to the Employer.

G. CLEANING AND INSPECTION OF SEWERS

1. CLEANING: clean pipeline of silt and debris after backfilling pipe trenches and completing manholes, hatch boxes etc. but before surfaces are permanently reinstated and make ready for inspection by the Engineer.
2. INSPECTION: pipelines of 900 mm diameter and over are, where practicable, to be inspected from the inside and when necessary a suitable trolley is to be provided for this purpose.
3. INSPECTION: pipelines less than 900 mm diameter and larger pipelines which cannot be inspected from the inside, are to be inspected by passing a cylinder of diameter 25 mm less than the internal diameter of the pipe and length not less than the internal diameter of the pipe through each pipeline.

H. BEDDING, HAUNCHING, ENCASEMENT AND THRUST BLOCKS

1. GENERAL

    a) CONCRETE WORK generally is to comply with the appropriate requirements of Sections E05 "In Situ Concrete Construction Generally", E10 "Mixing, Casting and Curing In Situ Concrete", E20 "Formwork for In Situ Concrete" and E30 "Reinforcement for In Situ Concrete".

2. PLACING CONCRETE

    a) AFTER PLACING PIPE place concrete in trench and thoroughly work under pipe to provide solid and uniform bedding.
    b) AFTER PIPE JOINT IS COMPLETED place balance of concrete or haunching and work into place on both sides simultaneously.
    c) FORM VERTICAL CONSTRUCTION JOINTS in concrete beds, surrounds etc. at face of pipe joints with compressible board and finish to profile of concrete and pipe. Fill any gap between spigot and socket with approved resilient material.

3. PLACING MATERIAL OTHER THAN CONCRETE

    a) PLACE BEDDING MATERIAL in bottom of prepared trench and carefully hand tamp to minimum thicknesses.
    b) AFTER PIPE HAS BEEN LAID, place additional material or haunching in successive layers not exceeding 150 mm thick on both sides simultaneously. Completely fill spaces between pipe and side of trench and carefully hand tamp without disturbing pipe.

4. THRUST BLOCKS

    a) GENERAL: provide thrust blocks at bends and junctions on pressure pipelines. Additional excavation required is to be made after pipeline has been jointed. No pressure is to be applied to the thrust block until concrete has matured for at least 3 days.

330.020 VALVES & ACCESSORIES

A. GENERAL

1. PRIOR TO INSTALLATION, inspect for cleanliness of bores, seating surfaces etc. and for handling damage, cracks, missing parts and tightness of pressure-containing bolting.
2. ENSURE valves, gates and hydrants are in closed position before installation.
3. OPERATE valves and hydrants through one complete opening and closing cycle in the position in which they are to be installed to ensure proper functioning.

B. INSTALLATION

1. VALVES

    a) SET AND JOINT valves to pipe in manner specified for laying and jointing pipe and/or to manufacturer's instructions.
    b) CONCRETE PADS: provide valves with concrete pads as per Section E10 and as shown on the Drawings so that pipe does not support weight of valve.
    c) VALVES WITHOUT CONCRETE PADS: place on firm footing to prevent settling and excessive strain on connection to pipe.
    d) DO NOT use valve to bring misaligned pipe into alignment during installation.
    e) INSPECT all pressure-containing bolting (bonnet, seal plate and end connections) for adequate tightness after installation but prior to field testing.

C. FIELD PROTECTION

1. VALVES: protect valves against action of external agents by a coat of approved bituminous compound applied cold by brush after pressure tests on pipelines have been completed.
2. GATES: protect against action of external agents with one coat of approved bituminous compound applied cold by brush after installation.
3. BOLTS: protect buried bolts against corrosion with approved paint or by polyethylene wrapping.

330.030 MANHOLES & CHAMBERS

A. GENERAL

1. EXCAVATION AND BACKFILLING generally are to comply with the appropriate requirements of Division D20 of the Specification.
2. CONCRETE WORK generally is to comply with the appropriate requirements of Sections: Sections E05 "In Situ Concrete Construction Generally", E10 and "Mixing, Casting and Curing In Situ Concrete", E20 "Formwork for In Situ Concrete" and E30 "Reinforcement for In Situ Concrete".

B. MANHOLES AND INSPECTION CHAMBERS

1. PRECAST UNITS: if used, shall have been cast at least 3 weeks before sections are used. Bed lowest unit on in situ concrete base and bed and haunch in cement mortar. Liberally coat joints of units with approved bituminous material of troweling grade prior to fixing. Ensure joints are filled solid and neatly strike off surplus compound. Do not disturb work for 7 days thereafter. Alternatively seal joints with approved preformed jointing strip in accordance with manufacturer's instructions. Bed precast concrete cover slab on top unit in cement mortar.
2. CHANNELS in bottom of manhole are to be smooth, semi- circular and size equal to diameter of adjacent sewers. For straight through manholes, construct channels of half pipe sections. Make changes in direction of flow with smooth curves as large as manholes permit. Changes in size and grade of channels are to be gradual and even.
3. BENCHING: form in sulphate resisting concrete as per Section E10 to rise vertically from top of channels to a height not less than soffit of outlet pipe, then slope upwards 1 in 10 to walls. Within 3 hours, float with coat of sulphate resisting cement-sand mortar 1:2 and finish smooth with steel trowel.
4. EXTERNAL COATING: cover faces of manholes and chambers with three coats applied by brush in accordance with manufacturer's instructions.
5. INTERNAL COATING: cover faces of manholes and chambers with four coats applied by brush in accordance with manufacturer's instructions.
6. ADJUSTMENT FOR LEVEL: build top courses of brickwork or blockwork after completion of surrounding levels. Adjust as necessary to give accurate and even final levels.
7. COVERS AND GRATINGS: bed frame solidly in mortar with cover in position to prevent twisting. Position centrally over opening and level and square with surrounding finishes.
8. TESTING OF MANHOLES: plug manhole inlets and outlets, fill manhole with water and allow to stand for at least 24 hours or such longer period to allow for complete absorption. Re-top with water. Allowable leakage over 24 hours is not to exceed 1% of total volume of manhole, otherwise make good and retest.

C. VALVE CHAMBERS

1. CONSTRUCTION: to be in situ concrete, precast concrete or blockwork as shown on the Drawings.
2. EXTERNAL COATING: cover faces of chambers with two to three coats applied by brush in accordance with manufacturer's instructions.
3. COVERS: bed frame solidly in mortar with cover in position to prevent twisting. Position centrally over opening and level and square with surrounding finishes.

R32A - COMPACTORS AND MACERATORS - MECHANICAL

- To be read in parallel with section R32B (Utilities)

PART 3 SPECIFICATION CLAUSES SPECIFIC TO R32A.

305.000 SUMMARY:

- This Section includes:
    1. Wheelie Waste Bins
    2. Chemical Waste Cabinet
    3. Hook lift container
    4. Bunded waste oil drum
    5. Standard pallet
- Drawings and general provisions of the Contract, including Conditions of Contract and Division 1 Specification Sections, apply to this Section.
- Comply, with applicable clauses relating to; workmanship, installation, work on site, fixing, access, marking, identification, labelling, accessories, testing and inspection, commissioning, operation and maintenance, training, system demonstration, notifications, spare parts and tools, quality control, safety, delivery, storage, protection, certification, programming, documentation, submittals, installation records, surveys, guarantee and warranty etc. as detailed in this section.
- Comply with the requirements of the infrastructure. The building services MEP contractor shall ensure that all building interfaces and tie in with the site wide infrastructure utilities is thoroughly coordinated in all aspects including setting out plans, coordinates, levels, type and finish of valve chambers, meter box, hand hole, etc.
-

310.000 PRODUCTS/MATERIALS:

310.001 WHEELIE WASTE BINS

- HDPE wheelie bins with solid colors stabilized against combined effect of water and UV rays.
- Different colors for different types of waste collected.
- Manufactured in accordance with UNE EN 840 European legislation.
- Capacity: 360 Liters and 1100 Liters.
- Medical waste bins shall have different color and labeled.
- Bins shall be compatible with IoT fill level sensor

310.002 CHEMICAL WASTE CABINET

- Double wall 18-gauge steel.
- 160 Kg. 350 lb. shelf capacity. Adjustable shelves.
- Sloped shelves safely direct spills away from containers.
- Recessed paddle handle can be used with padlock.
- Continuous piano hinge provides smooth closure.
- Self-closing doors.
- Adjustable leveling feet for uneven surfaces.
- Meets NFPA, OSHA and FM standards.
- Cabinet dimensions (LxWxH): 915mm x 450mm x 1830mm

310.003 HOOK LIFT CONTANIER

- Steel hook lift container used for storage of all types of dry waste and mixed recyclables.

- The container shall have a capacity of 15 cubic meters.
- The Structure shall be made of high-grade steel sheet, 6mm thickness welded to reinforcements for flooring.
- The dimensions shall be as shown on drawings, if different the contractor should ensure that the container is compatible with its space allocation, and its operation does not disturb any projected utilities and shall submit drawings and calculations that prove the latter.
- The container shall be compatible with standard multi-lifters.
- Paint shall consist of at least 2 coats of epoxy primer and at least 2 coats of epoxy exterior finish.
- Manufactured according to DIN standard.

310.004 BUNDED WASTE OIL DRUM

- These containers used for oily waste, oily and aqueous mud waste storage until waste collection period.
- Capacity: 55 Gallon
- Dimensions: (Dia x H) 980 x 1090 mm
- Material: premium grade, oil resistant Medium Density Polyethylene (MDPE)
- Lockable manhole access
- Meet all relevant regulatory requirements and are fully CE marked where appropriate.
- Conform to OFS T100 and hold an ERA2 rating.
- Can be forklifted from either side for ease of handling.
- Lifting eyes fitted for crane/hiab handling (empty only)
- Standard fitting includes tank contents gauge, 2" filler cap and 2" vent cap.
- Fittings enclosed under lockable lid for additional security.
- Bunded spill pallet Dimensions (L x W x H): 1200 x 1200 x 285 mm
- Bunded spill pallet Material: (Polyethylene) Robust HDPE Construction, corrosion resistant and UV protected.
- Bunded spill pallet Containment capacity: 200 L.
- Bunded spill pallet Maximum loading weight: 2722 kg
- Bunded spill pallet shall be Provided with 4-way entry for a Forklift or Pallet Jack.
- Bunded spill pallet shall be Dual Heavy Duty Removable Grates for easy access to the sump with a sump drain outlet.

310.005 STANDARD PALLET

- The basic storage unit for the cardboard bales shall be the standard pallet
- Standard dimensions: 1200 mm deep x 1000 mm wide x 200 mm high
- Empty weight: 23-25 Kg
- Preferred materials: wood.
- Type: full four-way entry, non-reversible, nine block style
- Shall have the greatest versatility with regard to handling mechanical equipment.
- Shall have a full perimeter base style.
- Shall be in accordance with ISO6780.
- Shall be able to carry cardboard bales.

320.000 WORKMANSHIP

320.010 WORK ON-SITE:

- Ensure all civil engineering, building works and service connections and installations are carried out.

320.020 INSTALLATION:

- Install, commission and set to work the waste volume reduction system in accordance with the manufacturer's recommendations, BS 5906 and the requirements of the local waste disposal authority.

320.030 QUALITY CONTROL:

- Handle, store and fix equipment and components of the waste volume reduction system in accordance with the manufacturer's recommendations so as to meet the design performance requirements.
- Inspect all components on delivery, before fixing and after installation and reject and replace any which are defective.
- Allow for thermal and building movement when fixing and jointing components.

S10A - COLD WATER - UTILITIES

PART 1 SYSTEM OBJECTIVES

100.000 OBJECTIVES

100.010 SUMMARY

A. This Section includes water-distribution piping and specialties outside the building for the following:

1. Combined water service and fire-service mains.
2. Fire Service mains
3. Water service

110.000 DESIGN PARAMETERS

110.010 PROJECT/SITE CONDITIONS

A. Existing Utilities: Do not interrupt or interfere with utilities serving facilities on the Project site or on adjoining property unless permitted by the Engineer under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated or directed:

B. Notify the Engineer not less than 72 hours in advance of proposed utility interruptions.

C. Do not proceed with utility interruptions without the Engineer's written permission.

D. Coordinate connection to sewer main with concerned authorities.

110.020 DEFINITIONS AND ABBREVIATIONS

A. The following are industry abbreviations for pipe materials:

1. PE: Polyethylene plastic.
2. PVC: Polyvinyl chloride plastic.
3. GRP: Glass-Fiber Reinforced Plastic

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. General

1. Drawings and general provisions of the Contract, including Conditions of Contract and Division A Specification Sections, apply to this Section.

B. Related Sections

1. Section D20 "Excavating and Filling" for excavating, trenching and backfilling.
2. Sections E05 "In Situ Concrete Construction Generally", E10 and "Mixing, Casting and Curing In Situ Concrete", E20 "Formwork for In Situ Concrete" and E30 "Reinforcement for In Situ Concrete" for concrete structures.
3. Section J40 "Flexible Sheet Waterproofing and Damp Proofing".

PART 3 MATERIALS AND WORKMANSHIP

300.000 MATERIALS

300.010 PIPES, FITTINGS AND ACCESSORIES

A. PIPES AND FITTINGS: IRON PIPE

1. PIPE: to BS EN 545.

2. FITTINGS: to BS EN 545, pressure rating suitable for type of pipe and with end combinations as shown on the Drawings.
3. JOINTS: spigot and socket ended pipes are to have rubber gasket joints.
4. JOINTS: flanged pipes are to have screwed-on or cast-on flanges to sustain working pressure of 16 bars.
5. FLANGES: to BS EN 1092, Part 2.
6. FACTORY PROTECTION FOR WATER SUPPLY PIPE:
    a) internally: cement lined to BS EN 545 with ordinary Portland cement to BS EN 197-1 to specified thicknesses.
    b) externally: coated with metallic Zinc to BS EN 545 and followed by a coat bitumen coat to BS 3416 min. thickness 150 microns.
7. FACTORY PROTECTION FOR FITTINGS:
    a) coated internally and externally by dipping, or other method, using bitumen coat to BS 3416 minimum thickness 250 microns.

B. PIPES AND FITTINGS: THERMOPLASTIC PIPE
1. POLYETHELENE (PE) PRESSURE PIPE
2. GRP PIPE

C. PIPES AND FITTINGS: STEEL PIPE

D. PIPE ACCESSORIES: TAPPING SADDLES:
1. CAST IRON

E. SERVICE CONNECTIONS

F. COMPRESSIBLE BOARD

G. FILLING MATERIALS UNDER AND AROUND PIPES

300.020 VALVES

A. GATE VALVES

B. BUTTERFLY VALVES

C. AIR VALVES
1. AIR VALVES FOR WATER MAINS

D. FLOW METERS

E. FIRE HYDRANTS
1. POST TYPE
2. UNDERGROUND TYPE

F. FERRULE COCKS AND STOP VALVES FOR SERVICE CONNECTIONS
1. FERRULE COCKS

2. UNDERGROUND STOP VALVES

G. JOINTING MATERIALS
1. FLEXIBLE COUPLINGS
    a) TYPE: gasketed sleeve type, to allow angular deflection and axial movement of two joined pipe ends and to maintain permanent, leak-tight joint.
    b) COMPONENTS comprise one centre sleeve, two end followers or flanges, two rubber-compounded wedge-section gaskets and sufficient draw bolts and nuts to properly compress gaskets. Tightening of bolts to draw end followers together is to compress gaskets in recess between centre sleeve and followers onto pipe ends to effect positive seal.

2. DISMANTLING COUPLINGS

a) .

300.030 VALVE ACCESSORIES AND OPERATORS

A. VALVE ACCESSORIES

300.040 CHAMBERS

A. COATING for internal surfaces of concrete chambers

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B. COATING for external surfaces of concrete chambers

C. COMPONENTS

310.000 QUALITY MANAGEMENT

310.010 GENERAL REQUIREMENTS

1. MANUFACTURER'S CERTIFICATE: materials are to be supplied with a certificate, in respect of each delivery, stating that products comply with and have been factory tested in accordance with specified Standards.
2. MARKING: unless otherwise specified in the relevant Standard products are to have legibly cast, stamped or indelibly painted on, the following marks, as appropriate:

   a) manufacturer's name, initials and identification mark
   b) nominal diameter
   c) class designation
   d) initials and number of relevant Standard
   e) length of pipe if shorter than standard length
   f) angle of bends in degrees
   g) date of manufacture.

3. SPECIAL TESTS: whenever required by the Engineer, supply and transport to a testing laboratory samples of materials selected by the Engineer. Number of samples is not to be more than 0.5% of total supplied, with at least one from each cl ass, diameter and manufacturer. Failure of any sample is to be followed by a second and if necessary a third test from the same batch. A third test failure will result in all material from that manufacturer being rejected and replaced by material from a different manufacturer, subject to approval and satisfactory tests. Provide laboratory test report in an approved form.

310.020 REGULATORY REQUIREMENTS

A. Comply with requirements of the utility company supplying water. Include tapping of water mains and backflow prevention.

B. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.

C. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

D. COMPLY with FM's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products whenever requested by Fire Department.

E. Compliance:

1. Comply with NSF 61, or approved equivalent, for materials for water-service piping and specialties for domestic water.

320.000 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for system materials and products.

B. Shop Drawings: Include plans, elevations, details, and attachments for the following:

1. Water pipe network, including pipe diameters and gradients.
2. Chambers and other structures, including invert levels, frames, covers, and grates.

C. Coordination Drawings: For piping and specialties including relation to other services in same area. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.

D. As-Built Drawings: At project close-out, submit record drawings of installed pipework and products, in accordance with requirements of the Specification, Division 1.

E. Maintenance Data: Submit maintenance data and parts lists for system materials and products. Include this data, product data, Shop Drawings, and submit drawings in maintenance manual; in accordance with requirements of the Specification, Division A.

F. Certificate of Compliance.

G. Field Quality-Control Test Reports: From Contractor.

H. Operation and Maintenance Data: For specialties to include in emergency, operation, and maintenance manuals. In addition to items specified in Division A include the following:

1. Water meters.
2. Valves.
3. Fire hydrants.

330.000 EXECUTION

330.010 PIPES, FITTINGS & ACCESSORIES

A. GENERAL

1. MANUFACTURER'S RECOMMENDATIONS on handling, repairing, laying, jointing, anchoring, testing and other works for pipes, fittings, valves and accessories are to be strictly followed.
2. LOADING AND UNLOADING: use cranes, hoists or skidways as directed by the Engineer. Use hooks, spreader beams, ropes, band or wire slings etc. as recommended by manufacturer for each type of pipe and as approved by the Engineer.
3. STACK pipes on level surface. Do not rest pipes on sockets or jointing fairlings. Securely chock end pipes in bottom row. Height of stack is to be to manufacturer's instructions.
4. HANDLE material with care to avoid damage whether moved by hand, skidways or hoists.
5. STORING: provide safe storage for material. Interior of pipes, fittings etc. are to be kept free from dirt and foreign matter. Provide shade for materials as required by manufacturer's instructions and to the Engineer's approval.
6. CUTTING: use hacksaws, manually operated wheel cutter or pipe cutting machine as per manufacturer's instructions. If, in the opinion of the Engineer, special precautions are to be taken to eliminate airborne particles, use methods and equipment as directed by the Engineer. Prepare ends according to type of joint used and follow manufacturer's recommendations. Take care not to damage lining, if any. Repair on site, minor damage, if permitted.
7. REPAIR DAMAGED COATING, SHEATHING OR LINING in accordance with the Specification and manufacturer's instructions. Use material compatible with that originally used. Repair is to be approved by the Engineer before incorporating materials into the work.

B. EXCAVATION AND EARTHWORK

1. EXCAVATION AND EARTHWORK including but not limited to pipe trenches, earthwork support, backfilling, disposal, and surface reinstatement are to be in accordance with the requirements of Section D20 of the Specification.

C. PIPE LAYING AND JOINTING

1. GENERAL

a) LOWERING: do not lower pipe into trench until pipe bed is brought to grade and approved.
b) LOWERING: use ropes, wire slings, band slings, spreader beams etc. as recommended by manufacturer for each type of pipe and as approved.
c) EXAMINE MATERIAL carefully for damage. Test for soundness in accordance with manufacturer's instructions before laying.
d) EXAMINE MATERIAL: ensure internal coating or lining and outer coating or sheathing are undamaged. If damaged, make good or dispose of as directed.
e) PIPE CLEANLINESS: remove dirt and foreign matter before lowering.
f) PIPE CLEANLINESS: clear construction debris from inside of pipe before making joint.
g) PIPE PLACEMENT: lay pipe on an even formation true to grade and line, with sockets (if any) facing up the gradient.
h) PIPE ON SOLID GROUND: cut holes in bottom of trench to allow proper jointing and for barrel of pipe to bear evenly on solid ground for its full length.
i) PIPE ON GRANULAR BEDDING: scoop out locally at sockets/couplings to enable pipe to rest uniformly on barrel and adjust to exact line and level. After testing lay and compact further granular material in 100 mm layers to levels shown on the Drawings.
j) PIPE ON CONCRETE BED OR SURROUND: provide rectangular blocks of concrete as per Section E10 for concrete bedding, made in approved moulds at least 14 days before use, and approved hardwood folding wedges. Provide two concrete blocks for each pipe, set and bone into correct level on formation bottom and lay pipe properly centred and socketed. Insert two hardwood folding wedges, of width equal to width of concrete block, between body of pipe and block and drive together until pipe is brought to exact level required. Leave blocks and wedges undisturbed while pipes are being jointed and concrete bed and haunch or surround are being placed. Ensure blocks and wedges are of sufficient size and strength to prevent settlement of pipes. Leave sufficient space to enable joints to be made, tested and inspected.
k) PIPE PLUGS: when pipe laying is not in progress, close open ends of pipes with properly fitted temporary wooden plugs or standard caps as directed.

2. JOINTING

a) MANUFACTURER'S INSTRUCTIONS are to be followed regarding cleanliness of joint surfaces, lubricant used, correct location of components, provision of correct gaps between end of spigot and back of socket for flexible joints etc.
b) DEFLECTION OF JOINT: do not deflect flexible joints beyond maximum permissible angles given by manufacturer and/or relevant Standard.
c) PATENT DETACHABLE AND FLEXIBLE JOINTS: strictly comply with special instructions issued by manufacturers of proprietary joints when laying and jointing.
d) DIFFERING PIPE AND FITTING MATERIAL: joint with adaptors as recommended by pipe manufacturer.

3. LINE AND GRADIENT

a) IN OPEN EXCAVATION: provide and maintain sight rails and boning rods properly painted to ensure correct alignment of pipe runs. Sight rails are to be positioned either vertically above the lines of pipes or immediately adjacent thereto. At no time are there to be less than three sight rails in position on each length of pipeline under construction to any one gradient.
b) IN HEADING: provide and maintain marks to establish line and level of pipeline. Marks are to be fixed in each working shaft and two further marks established in each length of heading.

4. FLOATATION

a) PREVENTION: whenever water is excluded from interior of pipe, place sufficient backfill above pipe to prevent floatation.
b) REMOVE any pipe that has floated, correct bedding and relay.

5. PIPES BUILT INTO STRUCTURES

a) TREATMENT OF EXTERNAL SURFACE: thoroughly clean outside surface of pipes to be built-in immediately before installation. Remove protective coating to metal pipes, where ordered. Roughen clay and concrete pipes as directed. Paint plastic pipes with

appropriate solvent cement and sprinkle with dry coarse sand whilst wet. Cut away sheathing from sections to be built-in and after installation restore protection up to external face of structure with approved bituminous material.

b) FLEXIBLE JOINTS: provide two flexible joints or flexible patented joints adjacent to structures. Place first joint not more than one pipe diameter from face of structure and second not more than the following distances away from first:

1) pipelines not exceeding 450 mm: 2 pipe diameters.

D. IDENTIFICATION: Arrange for installing green warning tapes directly over piping and at outside edges of underground structures.

1. Use warning tape or detectable warning tape over ferrous piping.
2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

E. FIELD TESTING

1. GENERAL

a) PROVIDE pumping equipment, pressure gauges, instruments and water needed for hydrostatic testing.
b) CARRY OUT TESTS in the presence of the Engineer.
c) FITTINGS AND JOINTS: permanently anchor fittings before testing and leave all joints exposed for checking.
d) TEST SECTIONS: limit test sections to not more than 500 m.
e) TEST SECTIONS: test pressure lines between valve chambers whenever possible.
f) TEST SECTIONS: test gravity sewers in sections between manholes.
g) TEST PLUG: secure end of main and test plug by struts.
h) CLOSED VALVE: do not test against a closed valve unless there is no acceptable alternative.
i) APPLY PRESSURE by manually operated test pump or, in the case of large diameter mains, by power driven test pump, if approved.
j) EXAMINE exposed joints and repair visible leaks.
k) FAILURE: should a test fail, locate leak and replace or make good defective pipe or replace and make good faulty joint. Retest main.
l) RECORDS: keep test records in an approved form. Hand original copy to the Engineer immediately after completion of test.
m) PRESSURE LINES: carry out hydrostatic test while pipeline is partially backfilled.

2. HYDROSTATIC TESTING OF PRESSURE PIPELINES

a) FILL PIPE slowly with water from lowest point. Do not use power-driven pump unless approved.
b) FILL ABSORBANT PIPES with water and allow to stand for at least 24 hours to allow complete absorption.
c) ENTRAPPED AIR is to be bled before pressurizing.
d) PRESSURIZING is to continue until specified test pressure is reached in lowest part of section under test. Bleed further quantities of entrapped air while raising pressure.
e) MAINTAIN TEST PRESSURE for specified test duration with pumping stopped.
f) REPRESSURIZE to original test pressure and record respective volumes of water pumped.
g) FAILURE: pipeline will be deemed to have failed test if:

1) visible leaks are detected, regardless of leakage being within specified limits
2) volume of water lost during period when pumping was stopped exceeds allowable leakage.

h) TEST PRESSURE: Unless otherwise specified, the test pressure shall be equal to 1.5 times the maximum working pressure of the pipeline as shown on the Drawings or as determined by the Engineer on Site, but shall in no case exceed 75% of the factory hydrostatic test pressure.

i) TEST PERIOD: 2 hrs.

j) ALLOWABLE LEAKAGE: 0.02 liters/mm dia/km length/day/10 m head of applied pressure.

3. Air Testing of Pipelines

    a) Test procedure to BS EN 1610.

4. VISUAL INSPECTION TEST

    a) TIMING: carry out test after total backfilling of length under test.
    b) LIMIT of length to be tested at one time is three full-length pipes unless otherwise approved.
    c) APPARATUS: use rubber tired bogies which do not damage lining of pipe and an adequate supply of electric lamps.
    d) CHECK joints by means of feelers to ensure rubber rings are correctly located.
    e) CHECK pipe barrel for visible cracks.

5. Hydraulic Individual Joint Test for Pipes Exceeding 1000 mm:

    a) Test Procedure to BS EN 1610.

6. DEFLECTION TESTS FOR GRP PIPES

    a) CONDUCT: deflection tests for GRP pipes as required by the Engineer at 3 stages. Deflection shall be measured at the spigot end at mid-point and at socket end.
    b) STAGE 1: at completion of primary backfill (deflection at this stage should be below 0.5%).
    c) STAGE 2: at final backfill (Maximum allowable deflection 2.5%).
    d) STAGE 3: six months after final backfill (maximum allowable deflection 4.0%).
    e) PIPES not passing the deflection tests at stage 2 or stage 3 will be removed and replaced.

F. WATER SUPPLY HOUSE CONNECTIONS

1. LOCATION: agree location of tapping with the Engineer before starting construction.
2. PROGRAMME connections to follow closely construction of main network.
3. TAPPING: drill, thread and tap ferrule cocks to manufacturer's instructions.
4. EXCAVATE, INSTALL, BED AND BACKFILL in same manner as main network.
5. TEST with main network but excluding water meter.
6. RECORDS: maintain accurate records of location of house connections to main network. Record details of the following:

    a) diameter
    b) length
    c) location
    d) stop valves.

7. SURVEY LOG BOOK: keep records in an approved survey log book, made available for inspection and handed to the Employer on completion. Transfer information to sketches and tables as agreed with the Engineer, provide three bound copies and hand to the Employer.

G. FLUSHING AND DISINFECTION OF WATER MAINS

1. PROCEDURE: to AWWA C651.
2. PROVIDE equipment, gauges, temporary connections, chlorine and water needed for flushing and disinfection.
3. PROVIDE equipment, gauges, temporary connections and chlorine needed for flushing and disinfection. Arrange with the Employer to draw water from existing sources.
4. SECTIONS: flush and disinfect mains in sections as directed by the Engineer.
5. DRAINING: use washout valves and fire hydrants to drain flushing and disinfecting water.
6. FIRST FLUSHING: before commencing disinfection, flush main until effluent is clean and then clean as directed. 1 to 2 times volume of pipe is usually required for such flushing.
7. TYPE OF CHLORINE: disinfect with chlorine gas or solutions of calcium hypochlorite or sodium hypochlorite and agree with the Engineer on method of application.
8. INITIAL DOSING is to be 40-50 ppm.
9. CONTACT PERIOD is to be 24 hours.
10. RESIDUAL CHLORINE: measure residual chlorine by orthotolidin test. Residual chlorine is not to be less than 5 ppm or test is to be repeated as directed.

11. FINAL FLUSHING: after disinfection, reflush network until chlorine concentration in water leaving main is less than 1 ppm.
12. TESTS: perform bacteriological tests to AWWA C651, Section 9. Number of samples is to be one per 1 km of main feeders and one per 0.25 km of distribution lines.
13. PROCEDURE AFTER CUTTING INTO EXISTING MAIN: generally to AWWA C651, Section 11.

H. FLUSHING AND DISINFECTION OF WATER STORAGE TANKS

1. Disinfect water storage tanks in accordance to AWWA C652: Chlorination with water having a free chlorine residual of 2mg/L after 24hr. At least one sample shall be analysed to indicate microbiologically satisfactory water before the facility is placed into operation.

I. FIELD PROTECTION AND COATING

1. IRON PIPES: polyethylene encasement is to be to ISO 8180 or in accordance with the manufacturer's instructions. Sleeving shall be heavy duty blue color polyethylene with a minimum thickness of 225 microns.
2. PATENTED DETACHABLE AND FLEXIBLE JOINTS: protect metal joints with mastic compound and protective tape in accordance with the manufacturer's instructions. Minimum overlap of tape is to be 25 mm. Press out firmly all folds and irregularities.

J. BEDDING, HAUNCHING, ENCASEMENT AND THRUST BLOCKS

1. GENERAL

a) CONCRETE WORK generally is to comply with the appropriate requirements of Sections: E05 "In Situ Concrete Construction Generally", E10 and “Mixing, Casting and Curing In Situ Concrete", E20 “Formwork for In Situ Concrete" and E30 "Reinforcement for In Situ Concrete".

2. PLACING CONCRETE

a) AFTER PLACING PIPE place concrete in trench and thoroughly work under pipe to provide solid and uniform bedding.
b) AFTER PIPE JOINT IS COMPLETED place balance of concrete or haunching and work into place on both sides simultaneously.
c) FORM VERTICAL CONSTRUCTION JOINTS in concrete beds, surrounds etc. at face of pipe joints with compressible board and finish to profile of concrete and pipe. Fill any gap between spigot and socket with approved resilient material.

3. PLACING MATERIAL OTHER THAN CONCRETE

a) PLACE BEDDING MATERIAL in bottom of prepared trench and carefully hand tamp to minimum thicknesses.
b) AFTER PIPE HAS BEEN LAID, place additional material or haunching in successive layers not exceeding 150 mm thick on both sides simultaneously. Completely fill spaces between pipe and side of trench and carefully hand tamp without disturbing pipe.

4. THRUST BLOCKS

a) GENERAL: provide thrust blocks at bends and junctions on pressure pipelines. Additional excavation required is to be made after pipeline has been jointed. No pressure is to be applied to the thrust block until concrete has matured for at least 3 days.

330.020 VALVES & ACCESSORIES

A. GENERAL

1. PRIOR TO INSTALLATION, inspect for cleanliness of bores, seating surfaces etc. and for handling damage, cracks, missing parts and tightness of pressure-containing bolting.
2. ENSURE valves, gates and hydrants are in closed position before installation.
3. OPERATE valves and hydrants through one complete opening and closing cycle in the position in which they are to be installed to ensure proper functioning.

B. INSTALLATION

1. VALVES

    a) SET AND JOINT valves to pipe in manner specified for laying and jointing pipe and/or to manufacturer's instructions.
    b) CONCRETE PADS: provide valves with concrete pads as specified in Section E10 and as shown on the Drawings so that pipe does not support weight of valve.
    c) VALVES WITHOUT CONCRETE PADS: place on firm footing to prevent settling and excessive strain on connection to pipe.
    d) DO NOT use valve to bring misaligned pipe into alignment during installation.
    e) INSPECT all pressure-containing bolting (bonnet, seal plate and end connections) for adequate tightness after installation but prior to field testing.

2. HYDRANTS

    a) JOIN hydrants to pipe in manner specified for laying and jointing pipe and/or to manufacturer's instructions.
    b) SET hydrants to established grades as directed by the Engineer.
    c) SET hydrants plumb with nozzles parallel with or at right angles to the curb. Where hydrants have a pumper nozzle, set the latter facing the curb. Where hydrants have two hose nozzles 90 deg. apart, set with each nozzle facing the curb at 45 deg. angle.
    d) Wet-barrel Fire Hydrants: provide for a breakaway flange.

3. ANCHORAGE

    a) Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches.
    b) Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

4. WATER METER

    a) Install water meters, piping, and specialties according to the utility company's written requirements.
    b) Water Meters: Install detector-type water meters in meter vault according to :). Include shutoff valves on water meter inlets and outlets and full-size valves bypass around meters. Support meters, valves, and piping on brick or concrete piers.

C. FIELD PROTECTION

1. VALVES: protect valves against action of external agents by a coat of approved bituminous compound applied cold by brush after pressure tests on pipelines have been completed.
2. HYDRANTS: apply one coat of paint, of colour specified by the Engineer, after backfilling and surface restoration is completed.
3. GATES: protect against action of external agents with one coat of approved bituminous compound applied cold by brush after installation.
4. BOLTS: protect buried bolts against corrosion with approved paint or by polyethylene wrapping.

330.030 CHAMBERS

A. GENERAL

1. EXCAVATION AND BACKFILLING generally are to comply with the appropriate requirements of Division D20 of the Specification.
2. CONCRETE WORK generally is to comply with the appropriate requirements of Sections: E05 "In Situ Concrete Construction Generally", E10 "Mixing, Casting and Curing In Situ Concrete", E20 "Formwork for In Situ Concrete" and E30 "Reinforcement for In Situ Concrete".

B. VALVE CHAMBERS

1. CONSTRUCTION: to be in situ concrete, precast concrete or blockwork as shown on the Drawings.
2. EXTERNAL COATING: cover faces of chambers with two to three coats applied by brush in accordance with manufacturer's instructions.
3. COVERS: bed frame solidly in mortar with cover in position to prevent twisting. Position centrally over opening and level and square with surrounding finishes.

S10B - COLD WATER

PART 3 SPECIFICATION CLAUSES SPECIFIC TO S10

300.000 PRODUCTS/MATERIALS

300.002 PRESSURE EQUIPMENT DIRECTIVE/PRESSURE EQUIPMENT REGULATIONS:

- All equipment and assemblies which fall within the scope of the Pressure Equipment Directive (PED) 2014/68/EU must be tested by the manufacturers, and be certified as compliant with the Directive. Such compliance shall be evidenced by displaying the appropriate CE Mark on the equipment and assemblies.
- Only relevant equipment and assemblies certified as compliant will be permitted under this specification, and any substitution put forward must also be compliant with the Directive.

300.005 COMPLIANCES:

- Ensure all water fittings and materials are in compliance with WRAS.

300.012 WATER METERS :

- Type
  - Turbine.
  - Electromagnetic.
    - Application
    - Install a water meter to the incoming mains supply. Locate the meter to allow for easy access for meter reading by the building's supervisor.
    - Standards - BS EN ISO 4064-1, BS EN ISO 4064-2, BS EN ISO 4064-3, BS EN ISO 4064-4
    - Meters for potable water to be compliant with WRc.
    - Meter connections
      - Flanged.
      - Screwed.
    - Maximum working pressure (bar) :as per design
    - Maximum water temperature (°C) :as per design
    - Minimum water temperature (°C) :as per design
    - Maximum flow rate (m^3/hr) :as per design
    - Minimum flow rate (m^3/hr) :as per design
    - Meter accuracy class to BS EN ISO 4064-1
      - For mechanical analogue cumulative meters provide a dial indicator to record quantity of water passed. Enclose mechanism of each meter within a cast iron body. Incorporate, as an integral part of each meter, a water guide at inlet to direct water evenly on to the meter. Provide each meter with a zeroing device.
      - Mechanical/electrical meters or meters with a digital indicating device and other types of electronic or magnetic meter, to be complete with all necessary components and facilities. These shall include transducer, sensor, adjustment and correction facilities, indicating device to display volume continuously or periodically on demand and facilities for interface with a BMS.
      - Ancillary (additional functionality) device complying with BS EN 14154-4 for Smart Metering
    - Device type

- Additional functionality device integrated into the meter (AFD1).
- Additional functionality device directly attached to the meter (AFD2).
- Additional functionality device remotely connected to the meter (AFD3).

- Ancillary device description:
  - Zero-setting device
  - Price-indicating device
  - Repeating indicating device
  - Printing device
  - Memory device
  - Tariff control device
  - Pre-setting device
  - Self-service device
  - Low sensor movement detector (for detecting movement of the flow sensor before this is clearly visible on the indicating device)
  - Remote reading device (which may be incorporated permanently or added temporarily
- Details
  - Provide isolating valves on either side of each meter, and full-bore valved bypass installed around meter assembly.
  - Provide facility for remote monitoring through pulsed output.
  - Electrical supply
  - 24V dc.
- Degree of protection to BS EN 60529
- A pulsed water meter must be installed to the mains water supply to each building, this includes instances where water is supplied via a borehole or other private source.
- The water meter must be connected to the building management system (BMS), if a BMS is installed.
- Sub-meters must be installed on any large water consuming plant or building area
- Comply with Issue ID Wat 02 Water Monitoring.

300.020 ORIFICE DISCS:

- Install orifice discs at connections to taps.

300.059 PRESSURISATION UNITS:

- Supply fully automatic pre-wired packaged unit on common base plate.
- Components
  - Covered suction tank with ball float valve and overflow connections.
  - Direct coupled centrifugal pressurisation booster pump as per section Z220b.
  - Standby pump with auto changeover.
  - Motor starter.
  - Non-return valve.
  - Pressure control switch.
  - Pressure gauge.
  - Pressure limit switches.
  - Interconnecting piping and isolating valve.
  - Use plant/pipework arrangement with re-circulating circuits to avoid stagnant water in pressurisation unit expansion vessel.

- Accessories
    - Supply manual fill unit for initial filling and routine maintenance.
    - Hours run meter.

310.000 WORKMANSHIP

310.005 INSTALLATION AND COMMISSIONING GENERALLY:

- Install, test and commission systems to comply with BS EN 806-4 and complimentary guidance in BS 8558, Water Supply (Water Fittings) Regulations or Bylaws and equipment manufacturer's recommendations.
- Flushing and disinfection of services supplying water for domestic use to be carried out in accordance with BS EN 806-4 and following the guidance in BS 8558 and PD 855468. Refer to the pipework cleaning and chemical treatment section of this specification for details.
- Construct the system to ensure it is safe and without risks to health and where applicable incorporate in the final design/installation recommendations given in HSG274 Part 2.
- Locate sampling points following the guidance and recommendations in the code of practice for sampling and monitoring of hot and cold water services, BS 8554 and document these in a sampling plan prepared in accordance with BS EN ISO 5667-1.
- Undertake sampling following construction completion in accordance with the guidance and recommendations in BS 8554.
- Undertake microbiological tests on samples and provide the results as part of the handover documentation to demonstrate that the systems are clear of organisms of concern. Preserve and handle samples in accordance with BS EN ISO 5667-3.
- Install thermoplastics pipework in accordance with BS 5955-8.

310.010 CONNECTIONS TO TAPS AND APPLIANCES:

- Make final connections to taps and appliances.
- For electrical appliances connected to water mains, comply with the manufacturer's recommendations and requirements of BS EN 61770 as below:
- To prevent the back siphonage of non-potable water into the water mains
- Flexible hose assemblies intended to be used as integral parts of appliances, to be in accordance with the standard
- Flexible hose assemblies designed for connecting appliances to drinking water installations to be in accordance with BS EN 13618.

310.022 INSTALLATION OF WATER METERS:

- Install water meters in accordance with manufacturer's instructions and BS EN ISO 4064-5
- Comply with the requirements of BS EN 14154-4 for additional functionality devices associated with Smart Metering.

310.030 INSTALLATION OF PRESSURE BOOSTER SETS:

- Install, test and commission pressure booster sets in accordance with manufacturer's recommendations.
- Install double check valves on quick fill connections.
- On healthcare projects comply with HTM 04-01 Part A.

310.070 EXCAVATION:

- Excavate in a clean and organised manner. Schedule with other site activities to provide controlled access and minimal tracking of soil over the site.
- Set out and use sight boards to ensure uniform falls.
- Separate top soil and set aside for later use.
- Excavate trench width to a minimum of 300mm above the top of the pipe barrel within indicated limits.
- Keep available materials for adequate shoring when excavation depth over 1.2m is intended in accordance with The Construction (General Provision) Regulations.
- Where rock is encountered in trench bottoms designed as Class D bedding further excavate to the depth necessary to receive Class F.
- Backfill over-excavation, whether intentional at soft spots or accidental with rubble.
- Spoil, which is either in excess of or does not fulfil the requirements for selected fill.
- Place in spoil heaps.
- Take off site as directed.

S11 - HOT WATER

PART 3 SPECIFICATION CLAUSES SPECIFIC TO S11

300.000 PRODUCTS / MATERIALS:

- Comply with EU Regulation 814/2013 with regard to ecodesign requirements for water heaters with rated heat output of up to 400kW and hot water storage tanks with a storage volume of up to 2000 litres regarding limiting standing loss and product information. Manufacturers to comply with the test methods in BS EN 50440 to measure the performance of electric storage water heaters.

300.002 PRESSURE EQUIPMENT DIRECTIVE/PRESSURE EQUIPMENT REGULATIONS:

- All equipment and assemblies which fall within the scope of the Pressure Equipment Directive (PED) 2014/68/EU, must be tested by the manufacturers, and be certified as compliant with the Directive. Such compliance shall be evidenced by displaying the appropriate CE Mark on the equipment and assemblies.
- Only relevant equipment and assemblies certified as compliant will be permitted under this specification, and any substitution put forward must also be compliant with the Directive.

300.005 APPROVALS:

- Ensure all water fittings and materials are compliant with WRAS.

300.030 STORAGE WATER HEATER(S):

- Type
  - Electric
- Supply and install
  - For appliances not exceeding 70kW and hot water storage capacity not exceeding 500 litres, manufacturer to have undertaken an assessment of performance of hot water delivery to BS EN 13203-1 and energy consumption to BS EN 13203-2.
  - Safety of electric storage water heater to BS EN 60335-2-21.
  - Safety of fixed electric immersion heater to BS EN 60335-2-73.
- Service
  - Single point.
- Water supply
  - Mains.
- Casing finish
  - White vitreous enamel.
- Heating element
  - Supply immersion heater complete with thermostat and heating element

300.040 ORIFICE DISCS:

- Install orifice discs at connections to taps.

300.050 THERMOSTATIC MIXING VALVES:

- Application : hot water system
  - (mixed water temperature 41°C).

- Valves to be compliant with WRAS.
- All non-metallic parts in contact with water shall meet WRAS requirements or comply with relevant parts of BS 6920 and BS EN 15768
- Valves to be independently tested and approved to BuildCert scheme:
  - TMV3.
- Standard/type
  - BS EN 1111 for high operating pressure (1-5bar)
  - For care establishments comply with:
    - HTM 04-01 supplement: performance specification D 08 - thermostatic mixing valves (healthcare premises)
    - BS 7942 (which complements BS EN 1111 and BS EN 1287 where a particular risk of scalding exists to the user)
      - Type C, without flow control and with pre-set temperature.
      - Category 1 - with electronic temperature adjustment, mixed water temperature changed progressively.
- Material
  - Body - DZR brass.
- Finish
  - Chrome plated

300.055 THERMAL CIRCULATION VALVES:

- Type
  - Thermostatically controlled self-balancing.
- Application
  - Thermostatic regulation of return water temperature in HWS systems with circulation pump.
  - Thermal disinfection at temperatures above 70°C.
- Location
  - In return pipework at bottom of each riser.
  - In return pipework from each run of fittings.
- Standard
  - To be compliant with WRAS
- Materials

- Body - bronze to BS EN 1982.
- Bonnet and associated parts - DZR brass.
- Stem - stainless steel.
- O-Ring seals - EPDM rubber, meeting WRAS requirements.
- Body seat - PTFE.

- Duty
  - Design flow (I/s) :as per design
  - Differential pressure (kPa) :as per design
  - Pressure rating: PN16.
  - Max temperature: (°C) :as per design
- Accuracy
  - +/- 2°C at set temperature.
- Features
  - Temperature gauge access point.
  - Adjustable temperature setting facility.
  - Additional thermostatic insert to increase flow when temperature of 70°C to effect disinfection.
  - Integral isolation valve.

300.060 MECHANICAL MIXING VALVES:

- Standard
  - BS EN 1286
    - Single control for adjusting flow rate and temperature.
      - Other mixing valves with separate control devices for adjusting flow rate and temperature.

300.080 EXPANSION VESSELS:

- Type
  - Diaphragm
  - Bladder
- Materials
  - Body material welded carbon steel
- Mounting details
  - Unit to be floor mounted.
  - Unit to be wall-mounted.
- Standards
  - BS 6144
  - Relevant parts of BS 6920
  - Supply expansion vessels with built in diaphragm for sealed hot water heating systems in accordance with BS EN 13831. For applications where the vessel water temperature is normally outside the range of 5 °C to 70 °C the test methods in this standard shall be

adapted in such a way that the test temperature corresponds to the temperature to which the diaphragm will be subject during operation.

- Application, selection and installation of expansion vessels to be in accordance with BS 7074-2.

310.000 WORKMANSHIP

310.005 INSTALLATION AND COMMISSIONING GENERALLY:

- Install, test and commission systems to comply with equipment manufacturer's recommendations, BS EN 806-4, complimentary guidance in BS 8558 and relevant Water Supply (Water Fittings) Regulations or Byelaws and equipment manufacturer's recommendations
- Flushing and disinfection of services supplying water for domestic use to be carried out in accordance with BS EN 806-4 and following the guidance in BS 8558 and PD 855468. Refer to the pipework cleaning and chemical treatment section of this specification for details.
- Construct the system to ensure it is safe and without risks to health and where applicable incorporate in the final design/installation recommendations given in HSG274 Part 2.
- Locate sampling points following the guidance and recommendations in the code of practice for sampling and monitoring of hot and cold water services, BS 8554 and document these in a sampling plan prepared in accordance with BS EN ISO 5667-1.
- Undertake sampling following construction completion in accordance with the guidance and recommendations in BS 8554.
- Undertake microbiological tests on samples and provide the results as part of the handover documentation to demonstrate that the systems are clear of organisms of concern. Preserve and handle samples in accordance with BS EN ISO 5667-3.
- Install thermoplastics pipework in accordance with BS 5955-8.
- Undertake thermal balancing of HWS and CWS systems in accordance with European standards.

310.020 CONNECTIONS TO TAPS AND APPLIANCES:

- Make final connections to taps and appliances.
- For electrical appliances connected to water mains, comply with the manufacturer's recommendations and requirements of BS EN 61770 as below:
- To prevent the backsiphonage of non-potable water into the water mains
- Flexible hose assemblies intended to be used as integral parts of appliances, to be in accordance with the standard
- Flexible hose assemblies designed for connecting appliances to drinking water installations to be in accordance with BS EN 13618.

310.040 INSTALLATION AND COMMISSIONING OF THERMOSTATIC MIXING VALVES:

- Install and commission thermostatic mixing valves and mechanical mixing valves in accordance with manufacturer's recommendations.
- On healthcare projects comply with HTM 04-01 Part A: design, installation and commissioning, and HTM 04-01 supplement: performance specification D 08 - thermostatic mixing valves (healthcare premises).
- For TMV3 approved valves comply with the scheme's installation and maintenance documentation requirements.

FOR TMV3 APPROVED VALVES COMPLY WITH THE SCHEME ONSITE TESTING REQUIREMENTS.

310.050 INSTALLATION OF WATER METERS:

- Install water meters in accordance with manufacturer's instructions and BS EN ISO 4064-5
- Comply with the requirements of BS EN 14154-4 for additional functionality devices associated with Smart Metering.

320.060 PRESSURISATION UNITEXPANSION TANK INSTALLATION:

- Install expansion vessels and ancillary equipment for systems including safety valve for low and medium temperature hot water heating systems in accordance with BS 7074-2.

S20A - TREATED WATER - MECHANICAL

PART 3 SPECIFICATION CLAUSES SPECIFIC TO S20A

300.000 GENERAL

300.002 PRESSURE EQUIPMENT DIRECTIVE/PRESSURE EQUIPMENT REGULATIONS:

- All equipment and assemblies which fall within the scope of the Pressure Equipment Directive (PED) 2014/68/EU must be tested by the manufacturers, and be certified as compliant with the Directive. Such compliance shall be evidenced by displaying the appropriate CE Mark on the equipment and assemblies.
- Only relevant equipment and assemblies certified as compliant will be permitted under this specification, and any substitution put forward must also be compliant with the Directive.

300.010 SYSTEM REQUIREMENTS:

- Select plant and equipment suitable to meet system objectives requirements.

300.030 STATUTORY AUTHORITIES:

- Ensure treatment complies with statutory authority and health and safety regulations.

300.040 MAINS WATER ANALYSIS:

- Obtain an analysis of mains water taken from site supply point. Check with local water authority to ensure analysis results are typical for site area and report variances for instruction.
- Submit a sample of water to water treatment specialist.
- The following analysis shall be done onsite by contractor for water in main tank before purchasing any water treatment equipment :-
    - Conductivity (uS/cm)
    - Total Dissolved Solids (mg/1)
    - pH
    - Chloride Cl (mg/1)
    - Calcium Ca (mg/1)
    - Magnesium Mg (mg/1)
    - Sodium Na (mg/1)
    - Potassium K (mg/1)
    - Total Hardness CaC03 (mg/1)
    - Alkalinity CaC03 (mg/1)
    - Total Iron Fe (ug/1)
    - Copper Cu (ug/1)

300.050 WATER TREATMENT METHODS:

- Scale control
    - Pre-treatment
        - Base exchange softening plant.

        - Reverse osmosis plant.
    - Control of microbiological fouling
        - Chemical
            - Biocides.
            - Biodispersants.
            - Biocides and biodispersants.

310.000 PRODUCTS/MATERIALS

310.070 FILTRATION EQUIPMENT:

- Multimedia Sand Filters
    - Application: Cold water system.
    - Factory-fabricated and tested, multimedia, sand-filter system of filter tank(s), media, piping, and controls for removing sediment particles from water.
    - Configuration
        - Duplex
        - Triplex
    - Filter Tank.
        - Corrosion resistant with distribution system and media
        - Construction
            - Steel filter tanks
            - FRP filter tanks
        - Service Valve
            - Diaphragm type hydraulically operated.
        - Piping
            - Stainless-steel pipe, stainless-steel fittings
            - PVC pipe and fittings with solvent-cemented joints
        - Joints
            - Flanged
            - Grooved
            - Threaded
        - Control
            - [For Duplex and Triplex Tank System: Automatic, electric time clock for control of filter system flow and backwash cycles; factory-wired for single, external electrical connection. System operation shall be continuous with bypass piping and not more than one tank in backwash cycle at same time.]
        - Support.
            - Skid Mounting.
    - Filtration efficiency

        - 98 percent removal of suspended particles 2 micrometers and larger from feedwater of listed filtrate design concentrations
    - Media Tank
        - Multiple with manifolded inlet, outlet, and drain piping and controls.
    - Media Tank Material
        - Carbon steel with lining material
        - FRP
    - Filter media
        - Graded Silica sand
- Carbon Filters
    - Application: As needed for softener / RO tank.
    - Simplex carbon filter, with media tank, media, and automatic backwash for:
        - Removing chlorine from water
        - Improving color, odor, and taste of water
    - Media Tank.
        - Construction
            - Steel filter tanks
            - FRP filter tanks
        - Media tank Material
            - Carbon steel
            - Stainless steel
            - FRP
        - Media
            - Activated charcoal
            - Ground charcoal
        - Control
            - Automatic for control of backwash; factory wired for single, external electrical connection.
        - Filtration efficiency
            - 98 percent removal of suspended particles 20 micrometers and larger from feedwater of listed filtrate design concentrations
- Freestanding Cartridge Filters
    - Simplex floor-mounted housing with replaceable element(s) for:
        - Removing suspended particles from water
    - Housing
        - Corrosion resistant; designed to separate feedwater from filtrate and to direct feedwater through water filter element(s); with element support(s) and base, feet, or skirt
        - Housing Material

        - Stainless steel tanks
    - Element
        - Replaceable; of shape to fit housing.
        - Media
            - Activated charcoal
            - Ground charcoal
            - Pleated polyester
            - Pleated PP
            - Wound polyester
            - wound PP
        - Filtration efficiency
            - [98] percent removal of suspended particles [10] micrometers and larger from feedwater of listed filtrate design concentrations
- Off-Floor Cartridge Filters
    - Simplex, wall-mounted housing with replaceable element for:
        - Removing suspended particles from water
    - Housing
        - Corrosion resistant; designed to separate feedwater from filtrate and to direct feedwater through water filter element; with element support.
        - Housing Material
            - Stainless steel tanks
            - PE or PP
            - Plastic
        - Housing Seal
            - NBR
    - Element
        - Replaceable; of shape to fit housing.
        - Media
            - Activated charcoal
            - Ground charcoal
            - Pleated polyester
            - Pleated PP
            - Wound polyester
            - wound PP
        - Filtration efficiency
            - [98] percent removal of suspended particles [10] micrometers and larger from feedwater of listed filtrate design concentrations

310.090 ULTRAVIOLET DISINFECTION:

- The UV disinfection facility shall form an integral part of the building management regime for the control of Legionella in water systems in accordance with CIBSE TM13: Minimising the

Risk of Legionnaires' Disease, and HSE Approved Code of Practice L8 and associated guidance HSG274 Part 2:The Control of Legionella Bacteria in Hot and Cold Water Systems, providing protection against Legionella, Cryptosporidium and Pseudomonas bacteria within the water system.

- Unit to comply with WRAS requirements.
- Type of system/lamp
    - Low pressure.
    - Low pressure amalgam.
    - Medium pressure.
- Application/system
    - Domestic water supply treatment.
    - Mains water treatment.
- Treatment cycle
    - Single pass.
    - Recirculating flow.
- Materials
    - UV chamber material - 316L stainless steel.
    - High purity quartz lamp sleeve/thimble
        - Synthetic/fused.
        - Doped.
- Design and finish
    - Fixed flanged
    - Loose flanged
    - Connections
        - BSP male/female
        - Flanged (PN)
    - Internal polish
        - 0.8Ra
        - 1.6Ra
- Duty
    - System sizing method
        - Wall dose to provide minimum level of UV intensity at the furthest location from the UV lamp (mJ/cm^2)
        - Average dose taking account of the wall dose (furthest distance from the UV lamp) and the area immediately in front of the UV lamp (mJ/cm^2)
    - Log reduction dose to result in a log reduction in the organism population (mJ/cm^2)
    - Peak flow rate (I/s) : as per design
    - Water velocity through system
        - No greater than 3m/s.
    - Ultraviolet transmittance
        - Assumed (90% UVT) T10.
    - Chamber pressure rating
        - 10 bar.

- System power requirements: 230V 1ph (A)

- Installation and mounting
  - Vertical (medium pressure systems)
    - Lamps on horizontal axis.
  - Horizontal.
  - Install unit and control panel in accordance with the manufacturer's recommendations.
  - All interconnecting wiring between control panel and UV unit to be by the manufacturer.
- Safety considerations
  - Mechanical lamp interlock for electrical connection for lamps.
- Control panel requirements and details
  - Material
    - Mild steel epoxy coated.
    - 304 stainless steel.
    - 316L stainless steel.
  - Degree of protection to BS EN 60529
    - IP54.
  - Fit over temperature protection device with volt free contacts.
  - Provide electronic ballast control lamp drivers.
  - Features and functions
    - UV intensity display.
    - Low dose alarm.
    - Lamp hour counter.
    - System running indication.
    - Push button membrane display.
- Ancillaries and accessories
  - Wiper
    - Manual.
    - Automatic
      - Utilise optical source counting.
      - Motor to be 24V dc.
      - Do not use limit switches and magnets.
  - UV intensity monitor to measure UV dose in mJ/cm^2
    - Analogue output.
    - 4-20mA output.
  - Temperature probe.
- Commissioning
  - System to be commissioned by the manufacturer.

310.110 BASE EXCHANGE WATER SOFTENER:

- Provide complete water softening plant, fully packaged, pre-assembled and pre-wired and factory tested as indicated
- Softener and the following ancillaries to be skid mounted

- Standards and regulations
    - BS EN 806
    - BS 8558
    - Regulation 31 of the Water Supply (Water Quality) Regulations 2001
    - BS EN 14743 - operation and testing of softeners for drinking water permanently connected to the mains supply.
    - BS EN 15161 - installation, commissioning, operation and maintenance of softeners permanently connected to the mains supply.
- Method of water supply
    - From booster pump.
- Feed water details
    - refer to section 300.040
- Arrangement
    - Double column (duty/standby).
- Softener sizing method
    - Capacity limited.
    - Flow rate limited.
    - Efficiency limited.
    - Regeneration interval limited.
- Regeneration initiation method
    - Time.
    - Water throughput.
    - Water quality.
    - Resin sensor.
- Regeneration type
    - Co-current.
    - Counter current.
    - Proportional brining.
- Salt type
    - Granular.
    - Tablets (pillows).
    - Pure vacuum dried (PVD).
- Salt handling method
    - 25kg bags.
- BMS interface is required
- Ancillaries to be provided by manufacturer
    - Softened water storage tank
    - Mains water break tank and booster set
    - Brine recovery system
- Distribution system details
    - Upper distribution Pipe material
        - Single, point type, fabricated from galvanized-steel pipe and fittings
    - Lower distribution Pipe material

        - nonmetallic pipe and fittings with individual, fine-slotted, nonclogging plastic strainers
    - System pressure rating (PN): as designed.
- Prefabrication, installation, testing and commissioning
    - Comply with WRAS IGN 9-07-01.
    - Comply with British Water Code of Practice for the installation of salt regenerated ion exchange water softeners for direct connection to the mains water supply Ref BW:COP 3/00.
    - Prefabrication/factory assembly

320.000 WORKMANSHIP

320.005 INSTALLATION GENERALLY:

- Install, test and commission systems to comply with equipment and equipment manufacturer's recommendations, BS EN 806-4 and complimentary guidance in BS 8558,
- Install thermoplastics pipework in accordance with BS 5955-8.

320.010 INSTALLATION OF PLANT:

- Install treated water plant in accordance with manufacturer's recommendations.

S31 - INSTRUMENT AIR

PART 3 SPECIFICATION CLAUSES SPECIFIC TO S31

300.000 GENERAL

300.002 PRESSURE EQUIPMENT DIRECTIVE/PRESSURE EQUIPMENT REGULATIONS:

- All equipment and assemblies which fall within the scope of the Pressure Equipment Directive (PED) 2014/68/EU must be tested by the manufacturers, and be certified as compliant with the Directive. Such compliance shall be evidenced by displaying the appropriate CE Mark on the equipment and assemblies.
- Only relevant equipment and assemblies certified as compliant will be permitted under this specification, and any substitution put forward must also be compliant with the Directive.

300.005 COMPRESSED AIR QUALITY (PURITY):

- Supply compressed air at pressures and in quantities as schedule ref **[...]**
- Compressed air purity classification leaving the central plant in accordance with BS ISO 8573-1 for aerosol solid particulates, humidity and oil content shall be as follows
  - Solid particulates
    - 4
  - Water vapour pressure dewpoint/liquid water
    - 4
  - Total oil (aerosol liquid and vapour)
    - 4
- Compressed air purity classification for specific applications after local filters and/or dryers in accordance with BS ISO 8573-1 (Particles:Water:Oil) shall be as follows
  - Purity class to BS ISO 8573-1
- Test methods for the range of contaminants to be in accordance with Parts 2-9 of BS ISO 8573.

300.030 INFORMATION PLATES:

- Provide non-ferrous metal information plates with complete data on compressor, motor and receiver.

300.040 WORKS INSPECTION:

- Include for inspection at manufacturer's works by Insurance Company inspector or other person appointed in accordance with applicable regulations.

300.050 PERFORMANCE TESTS:

- Standards
  - Carry out performance tests displacement for compressors in accordance with BS ISO 1217 and BS EN 286-1 for air receivers when part of a packaged unit.

- Carry out performance tests for air receivers in accordance with BS EN 286-1.
- Undertake acoustic tests in accordance with BS EN ISO 3746 to determine sound power levels.

300.060 PRESSURE LIMITATIONS:

- Limit main distribution pressure to 6.0 bar gauge and branch distribution pressure to 1.5 bar gauge.

300.070 HIGH PRESSURE MAINS IN OCCUPIED SPACES:

- Do not install exposed high pressure mains in occupied spaces.

310.000 PRODUCTS/MATERIALS

310.010 AIR COMPRESSORS:

- Duty
  - Compressed air quality class to BS ISO 8573-1
- Compressor type
  - Reciprocating.
- Assembly
  - Single unit.
- Compressor lubrication
  - Oil lubricated.
- Compressor drive
  -
  - Belt.
- Cooling
  - Air cooled.
- Motor - Provide air intake filter and silencer.
- Mode of operation of compressor plant
  - Continuous.

310.020 AFTER COOLERS:

- Supply after coolers complete with moisture separator. Ensure discharge air temperature does not exceed 12°C above cooling medium temperature.
- Cooling medium
  - Air.
- Drain
  - Automatic drain cock.

310.040 COMPRESSED AIR DRYERS:

- Standard - test in accordance with BS ISO 7183
- Type of compressed air dryer
    - Refrigeration dryer
        - Refrigerant
            - R134a.
            - R410a.
            -
- Accessories
    - Hygrometer.
    - Integrated activated carbon pack and outlet membrane filters.
- Location
    - After air receiver.
    - Indoors.

310.050 AIR FILTERS:

- Standard
    - Test coalescing filters for removal of oil aerosols in accordance with BS ISO 12500-1
    - Test adsorption filters for removal of oil vapours and odours in accordance with BS ISO 12500-2
    - Test coalescing and dust removal filters for removal of solid particulates in accordance with BS ISO 12500-3
    - Comply with the requirements of the relevant parts of BS ISO 5782 for the characteristics of filters to be included in product literature and product marking requirements.
- Material
    - Fabricated steel.
- Connections
    - Flanged to BS EN 1092-3 PN
    - Fabricated steel to BS EN 1092-1
    - Screwed to relevant parts of BS EN 10226.
- Protection
    - General purpose.
    - Oil free.
    - Odour and vapour removal.
- Ancillaries
    - Differential pressure monitoring gauge.
    - Automatic drain trap.
- Specialty Installation
    - Install coalescing filters in compressed-air piping at or near air compressors and upstream from mechanical filters.

- Install mechanical filters in compressed-air piping at or near air compressors and downstream from coalescing filters.

310.055 WATER SEPARATORS:

- Standard – test in accordance with BS ISO 12500-4.
- Material
  - Cast aluminium alloy.
- Connections
  - Flanged to BS EN 1092-3 PN
  - Fabricated steel to BS EN 1092-1
  - Screwed to relevant parts of BS EN 10226.
- Ancillaries
  - Differential pressure monitoring gauge.
  - Float operated automatic drain trap.

310.060 AIR RECEIVERS:

- Standard - BS EN 286-1.
- Class
  - Class 1
- Spare capacity
  - Provide one spare receiver equal in capacity to the largest receiver fitted initially.
- Components
  - Safety valve.
  - Pressure gauge.
  - Condensate drain cock.
  - Inspection openings.
  - Control pressure switch.
  - Standby pressure switch.
  - Automatic drain.
  - Inlet isolating valves.
  - Outlet isolating valves.
  - Supporting feet.
- Accessories
  - Matching flanges.
- Regulations - Comply with statutory regulations.

310.070 INSTRUMENT AND CONTROL PANEL:

- Enclosure
- House control and instruments in protective enclosure. Protection in accordance with BS EN 60529 IP
- Functions - Start/stop button.
  - Programme change.
  - Auto start/stop with run-on timer.

- Output display
    - Digital.
- Output information
    - Discharge pressure.
    - Intermediate pressure.
    - Air temperature.
    - Oil temperature.
    - Filter condition - air.
    - Filter condition - oil.
    - Timed drainer intervals.

310.080 PNEUMATIC RELAYS:

- Provide electro-pneumatic relays for interlocking purposes.
- Provide electro-pneumatic relays so that on plant failure or shutdown, the control returns to its zero position.

310.090 AVERAGING RELAYS:

- Provide averaging relays for:
    - averaging two control signals.
    - reversing the control signal and pressure.
    - selecting the lower or higher of two pressures to give selection control.

310.100 THERMOSTATIC CHANGEOVER SWITCH:

- Use snap action changeover switch rated at 5 amps full load at 240volt AC actuated by the pressure of liquid filled remote bulb and capillary tubing on a bellow. Provide means of adjustment on front cover via a temperature setting knob.

310.110 PNEUMATIC SENSORS - DISCHARGE CONTROL:

- Use pneumatic sensors consisting of a liquid filled averaging type sensor for discharge air control.

310.120 PNEUMATIC SENSORS - EXTRACT AIR CONTROL:

- Use rod and tube insertion element sensors for extract air control. Use sensors suitable for continuous temperature indication with a calibrated gauge.

310.130 PNEUMATIC SENSORS - HUMIDITY CONTROL:

- Sensing element
    - Foil dielectric gold coated.
    - Control range 20 to 90% RH.

310.140 PNEUMATIC ROOM SENSORS - DIRECT ACTING ROOM SENSORS:

- Sensor type
  - Direct acting.
- Range
  - Use thermostats with a range set point of 15- 30°C and a throttling range of 1.1 to 5.5°C.
- Cover
  - Metal cover with display of temperature set point.

310.160 PNEUMATIC CONTROLLERS:

- Use pneumatic controllers with all sensors factory calibrated and with adjustments, calibrations etc on receiver controllers located
  - in cabinets adjacent to plant being controlled.
- Indication
- Incorporate means of indication of temperature, humidity and pressure on controllers.
- Operation
  - Proportional operation.
- Accessories
  - Provided with a remote control point adjustment (CPA).
- Range
- Ensure range of pneumatic receiver controllers cover dual input controllers for
  - low limit.
  - high limit.
  - compensated winter schedules.
  - compensated summer schedules.

310.166 FLEXIBLE THERMOPLASTIC HOSES:

- Flexible hoses to be textile-reinforced and in accordance with BS EN ISO 5774 and be suitable for the maximum working pressure / temperature of the system.
- Hoses to be complete with suitable and correctly fitted couplings and end fitted end fittings to form hose assemblies. End fittings to be either quick-release / quick acting type, screw threaded or socket and spigot type to suit the application.
- Install flexible hoses:
  - Where indicated on drawings.
  - At final connections to equipment.

310.180 SAFETY VALVES:

- Standard - fit pop type valves to BS EN ISO 4126-1 and BS EN ISO 4126-7.
- Material
  - Bronze bodies with bronze trim.
- Connections

- Male screwed bottom inlet.

310.190 PILOT OPERATED SAFETY VALVES:

- Standard
  - Fit pilot controlled diaphragm operated type valves with single seat to BS EN ISO 4126-4 and BS EN ISO 4126-7.
- Materials
  - Steel bodies.
- Connections - flanged to BS EN 1092-1 PN 16
- Accessories
  - Provide an external tapping to sense upstream pressure.
  - Ensure variation of set pressure in either direction is possible while valves are in service.

310.200 PRESSURE REDUCING VALVES - INTEGRAL SENSOR TYPE:

- Components and materials
  - Copper alloy body screwed to relevant parts of BS EN 10226.
  - Stainless steel valve and seat and return spring.
  - Phosphor bronze bellows.
  - Control spring and handwheel.
  - Integral sensor with an alpha/numeric pressure set-point indicator and locking facility.

310.210 PRESSURE REDUCING VALVES - PILOT OPERATED TYPE:

- Components
  - Stainless steel valve and seat and return spring.
  - Stainless steel diaphragm.
  - Control spring.
  - Single seat design for tight shut off.
  - Pressure control pipe with stop cock.
  - Pressure setting handwheel with padlock.
  - **[...]**
- Material
  - Cast iron body.
- Connections
  - Screwed to relevant parts of BS EN 10226.

310.220 PRESSURE CONTROL VALVES - DIRECT ACTING TYPE:

- Components
  - Copper alloy body screwed to relevant parts of BS EN 10226.
  - Stainless steel valve and seat and return spring.
  - Phosphor bronze bellows.
  - Control spring and handwheel.
  - Integral sensor with an alpha/numeric pressure set-point indicator and locking facility.

310.230 SAFETY PRESSURE RELIEF VALVE:

- Install a safety pressure relief valve which actuates an audible alarm on downstream side of each pressure reducing valve.

320.000 WORKMANSHIP

320.005 SAFETY OF INSTALLATION:

- Ensure controls comply with BS EN 1012-1
- Safety devices
    - High air discharge temperature lock out switch.
    - Cooling water failure lock out switch.
    - Low oil pressure cut out

320.010 PIPEWORK INSTALLATION:

- Install pneumatic piping for complete pneumatic controls installation.
- Carry out a pneumatic leak test followed by a pneumatic pressure test as described in TR/6 Site pressure testing of pipework. Building Engineering Services Association. Guide to Good Practice.
- Install piping concealed from view and protected from physical contact by building occupants, unless otherwise indicated and except in equipment rooms and service areas.
- Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.
- Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and to coordinate with other services occupying that space.
- Install fittings for changes in direction and branch connections.
- Install piping free of sags and bends.
- Where installing piping adjacent to machine, allow space for service and maintenance.
- Install piping to permit valve servicing.

320.015 EQUIPMENT INSTALLATION:

- Maintain manufacturer's recommended clearances for service and maintenance.
- Install compressed-air equipment anchored to substrate.
- Arrange equipment so controls and devices are accessible for servicing.
- Install the following devices on compressed-air equipment:
    - Thermometer, Pressure Gage, and Safety Valve: Install on each compressed-air receiver.
    - Pressure Regulators: Install downstream from air compressors and dryers.
    - Automatic Drain Valves: Install on aftercoolers, receivers, and dryers. Discharge condensate over nearest floor drain.

320.020 SUPPORTS:

- Clip pipework at maximum intervals of 1.0m.
    - Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.

320.030 DISTRIBUTION:

- Lay out compressed air distribution lines to follow services routes and to group similar plant items.

320.040 MULTIPLE RUNS:

- Ensure all multiple runs of tube in plant areas and false ceilings and ducts are in trunking or on perforated sheet steel cable tray.

320.050 CONNECTION TO VALVES:

- Use copper pipework where connections are made to valves and sensing elements.

320.060 SLEEVES:

- Provide sleeves where pneumatic piping is run through walls or other members.
- Install sleeve seals for piping penetrations of concrete walls and slabs

320.060 ESCUTCHEONS:

- Install escutcheons for piping penetrations of walls, ceilings, and floors

320.070 PIPELINES WITHIN BUILDING FINISHES:

- Where run within building finishes protect pneumatic tubes from accidental damage during installation. Where run in walls or columns install pneumatic tubes with PVC conduit (high impact).

320.080 ISOLATION:

- Provide means of isolation
    - at all branches.

320.090 ISOLATING VALVES AND PRESSURE GAUGES:

- Install isolating valves and pressure gauges on upstream and downstream side of each component.

320.100 VALVES AND SAFETY DEVICES GENERAL:

- Mount vents, safety valves and fusible plugs so that they discharge safely. Comply with the manufacturer's installation and commissioning requirements.
- Provide safety valves in accordance with BS EN ISO 4126-1 and BS EN ISO 4126-7 and fusible plugs in accordance with BS 1123.
- Install safety devices in accordance with BS ISO 4126-9.
- Install check valves to maintain correct direction of compressed-air flow to and from compressed-air piping specialties and equipment.

- Install shutoff valves and unions or flanged joints at compressed-air piping to air compressors.
- Install shutoff valve at inlet to each automatic drain valve, filter, lubricator, and pressure regulator.
- Install safety valves in receiver tanks, in quantity and size to relieve capacity not less than that of connected compressor.

320.110 FALLS:

- Ensure the mains system falls to proper drain points and that fall is at least 25mm in 120 metres in direction of air flow.

320.120 BRANCH LINES:

- Take all branch lines off mains from top of the main.
- Provide drain leg and drain trap at end of each main and branch and at low points.

320.130 DRAIN POINTS:

- Provide drain points complete with strainer, air trap and discharge pipe.
- Install air and drain piping with 1 percent slope downward in direction of flow
- Install automatic drain valves on intercoolers, aftercoolers, separators, receivers, dryers, and other locations indicated. Discharge condensate over nearest floor drain.

320.140 PRESSURE REDUCING AND CONTROL VALVES:

- Install valves in horizontal pipelines and include moisture traps, strainers, pressure gauges and safety valves according to application and to manufacturer's recommendation.
- Install air-main pressure regulators in compressed-air piping at or near air compressors.
- Install air-line pressure regulators in branch piping to equipment and tools.

320.150 SAFETY REQUIREMENTS:

- Ensure controls comply with BS EN 1012-1
- Safety devices
    - High air discharge temperature lock out switch.
    - Cooling water failure lock out switch.
    - Low oil pressure cut out.

S33 - LIQUEFIED PETROLEUM GAS

PART 3 SPECIFICATION CLAUSES SPECIFIC TO S33

300.000 GENERAL

300.005 REGULATIONS:

- Supply and install equipment in accordance with NFPA 58 and NFPA 54, and the health and safety recommendations and requirements of the Local Authorities having jurisdiction. Where system components are not covered by NFPA standards, BS/EN standards shall be followed.

300.020 STANDARDS:

- Store and use LPG in accordance with all relevant NFPA 58, and requirements of local authorities.
- Design, install, test and commission LPG service pipework in both the liquid phase and at full vapour pressure from cylinders or bulk storage vessels to the emergency control valve outside the building in accordance with NFPA 58.
- For installation of low pressure pipework up to 35mm, downstream of the final regulator / primary meter installation or emergency control valve on the outside of the property associated with the service pipework, comply with NFPA 58.
- For the installation and maintenance of low pressure gas installation pipework of up to 35mm in domestic premises, comply with NFPA 58.
- Install in accordance with NFPA 58 and NFPA 54.

310.000 PRODUCTS/MATERIALS

310.010 STORAGE VESSELS:

- Type: Fixed type Underground
    - Vessel standards
        - NFPA 58
        - ASME Boiler and Pressure Vessel Code and bearing the ASME label.
    - Ancillaries standards
        - Pressure relief valves for LPG pressure vessels to NFPA 58
- Accessories and Fittings
    - Pressure Relief Valve connected to the vapor space.
    - Drain valve.
    - Maximum Level Fill Stop Valve.
    - LPG tank level gage to indicate current level.
    - LPG tank pressure gage.
    - Filling connection.
    - Service outlet connection
    - Shut-off and emergency valves
    - Excess flow valves

- Check Valves
- Temperature gauge

310.015 GAS VAPORISERS:

- Assembly shall be FMG labeled and comply with NFPA 58 and NFPA 70.
- Type: Indirect-Type, Direct-Fired Heat Exchanger
    - Description: LPG, vaporizer vessel with a replaceable, immersion-type, electric heating element.
    - Heating Element Operating Controls:
        - Safe operating conditions.
            - Microprocessor-based control system integrates safety and operating controls.
        - Operating Vapor-Pressure Control.
        - High-Pressure Cutoff.
        - Alarm Bell and Rotary Beacon.
- Vessel standards
- Ancillaries standards
    - Tank valves and fittings.
    - Pressure relief valves for LPG pressure vessels to NFPA 58 as applicable.
- Building Management System Interface:
    - Factory-installed hardware and software
    - Monitor and control set points
    - Display vaporizer status and alarms.

310.030 GAS PRESSURE REGULATORS AND AUTOMATIC CHANGE-OVER DEVICES:

- Application Service Pressure Regulators
- Type of pressure reduction
    - Single stage installation.
    - Two stage installation.
    - Three stage installation
- Standards
    - NFPA 58
- Duty
    - Maximum supply pressure as per design.
- Application (Line/Installation Pressure Regulators)
- Type of pressure reduction
    - Single stage installation.
    - Two stage installation.
- Standards
    - NFPA 58

310.031 GAS DISTRIBUTION PIPING:

- LPG distribution piping and joints and fittings to conform to NFPA 58 and ASTM standards

310.032 GAS METERS:

- Standards
  - Gas meter unions and adaptors in accordance with BS 746
  - BS EN 1359 - Diaphragm type gas meters
  - BS EN 14236 - Ultrasonic (domestic application) gas meters
  - Install, test and commission small natural gas meters for systems up to 6m^3/h and max operating pressure up to 2bar in accordance with BS 6400-3
  - PD CEN/TR 16061 - Smart meters
  - Low pressure meter installations to IGEM/GM/6
    - Diaphragm
    - Rotary displacement
  - Where a meter is used to measure the amount of energy supplied for billing purposes, the meter and associated volume/energy conversion device must be approved under the European Measuring Instruments Directive (MID) 2014/32/EU - Annex IV (MI-002): Gas meters and volume conversion devices; or approved by the Local Authorities having jurisdiction.
- Accessories
  - Filtration to at least 200 micron
  - Remote reading facility
  - Provide pulsed output for BMS monitoring
  - Volume conversion device to BS EN 12405-1
  - Energy conversion device to BS EN 12405-2
  - Flow computers that are intended to operate with gas turbine meter to BS EN 12261 to comply with BS EN 12405-3

310.040 TERMINAL CONTROL EQUIPMENT AND CONNECTIONS TO APPLIANCES:

- Regulators
  - First stage.
  - Second stage.
- Rubber and plastics hoses, tubing and assemblies for connection of appliances from regulator to comply with BS EN 16436.

310.050 GAS DETECTION AND ALARM EQUIPMENT:

- Detectors:
  - Inflammable Gas Detector: Combustible gas detector shall be diffusion type catalytic sensor in housing suitable for the environment.
  - Oxygen Detector: Oxygen detector shall be a paramagnetic cell. Minimum shelf life shall be 6 months. Measurement shall be adjustable through a range of 0 to 25 percent oxygen-in-air, and actuation level shall be set at 19.5 percent oxygen.
- Power Supply:

- Primary power supply.
- Alternate source of power, arranged to become energized automatically within at least ten seconds upon loss of normal power, in accordance with NFPA 110 shall be provided.

- Standards
  - BS EN 50271.
- Details
  - Control Unit
    - General Requirements:
      - Control unit shall be 4 channel, operating over a temperature range of 0 to 51 degrees C.
      - Each control unit shall be capable of monitoring 4 detectors.
      - Control unit shall be housed in a weatherproof cabinet suitable for wall mounting.
      - Relays shall be solid state type.
      - Rectifiers shall be solid state type.
    - Control Circuits: Circuits shall be solid state, with plug-in type circuit boards, in housing suitable for non-hazardous locations.
    - Power Supply component shall be incorporated in the control unit, with charger and batteries.
    - Indicator Light and Reset:
      - Each control unit shall have buttons for test, and indicator lights for Power, Malfunction, and Alarm.
      - Indicator lamps shall be color coded as follows: Power (green), Malfunction (yellow) and Alarm (red).
      - Zero, Alarm, and Calibration settings shall be adjustable.
    - Malfunction Circuits.
    - Alarm Unit shall be rotating alarm beacon.

310.055 GAS SAMPLING SYSTEM:

- Detectors:
  - Inflammable Gas Detector: inflammable gas detector shall be Galvanic cell method type. Measuring accuracy shall be within ±5% of full scale.
  - Oxygen Detector: Oxygen detector shall be Catalytic combustion method type. Measuring accuracy shall be within ±0.7% of oxygen concentration.
- Power Supply:
  - Primary power supply.
  - An alternate source of power, arranged to become energized automatically within at least ten seconds upon loss of nor-mal power.
- Standards
  - BS EN 50271.
- Details
  - A sequential sampling system for detection of LPG in the different spaces. The system shall detect inflammable gas and oxygen in air by applying the detection principle of

catalytic combustion method and galvanic cell method respectively and transmits representative alarm by means of re-lay contacts

310.070 EXTRA MATERIALS:

- Portable multi-gas detector; Provide two portable multi-gas detectors at any LPG distribution site to be used for periodic testing at the facility. As a minimum, the following characteristics need to be ensured;
    - Simultaneously monitor and display up to five atmospheric hazards.
    - Adaptable to a variety of applications, with an extensive selection of user-settable field options
    - Passcode function to prevent unauthorized modifications of the instrument's settings
    - Characteristics;
        - Temperature: -4 to +122°F / -20 to +50°C
        - 14 to +104°F / -10 to +40°C (PID)
        - Alarms:
            - Visual, vibrating, audible (95 dB)
            - Low, High, STEL, TWA, OL (over limit)
        - Tests: Sensor integrity, circuitry, battery and audible/visual alarms on activation, battery (continuous)
        - Ratings:
            - EMI/RFI: Complies with EMC Directive 89/336/EEC
            - IP 65/66
        - Certifications and Approvals: CE certified.

320.000 WORKMANSHIP

320.010 INSTALLATION:

- Install all electrical equipment in the storage area to BS EN 60079
- Install LPG system including bulk storage pipework distribution system to the building and appliances in accordance with NFPA 58 and NFPA 54, and the requirements and recommendations of the Local Authorities having jurisdiction.

S41 - FUEL OIL STORAGE AND DISTRIBUTION

PART 3 SPECIFICATION CLAUSES SPECIFIC TO S41

300.000 PRODUCTS/MATERIALS

300.005 STANDARDS AND REGULATIONS:

- Comply with NFPA 30 and the relevant requirements and recommendations of the Local Authorities having jurisdiction. Where system components are not covered by NFPA standards, BS/EN standards shall be followed.

300.006 GENERAL (FUEL PUMPS):

- Description: Comply with UL 79, UL 87, and UL 343.
- Comply with general clauses below
    - Pumps generally - reference Y20.1010
    - Pump selection for efficiency/EC ecodesign requirements - reference Y20.1020
    - Safety guards - reference Y20.1030
    - Pump testing - reference Y20.1040
- Comply with section Y92A for specifications of starters and VSD.
- Controls: Pump controller panel complying with UL 353 and UL 508C and with interlock and terminals for connections to diesel-driven emergency generators

300.007 FUEL OIL CHARACTERISTICS:

- Diesel oil

300.030 BELOW GROUND STEEL OIL STORAGE TANKS:

- Standard - UL 58 and STI P3
- Tank type
    - Fabricated double skinned tank
    - Containment Method: STI-P3, Type II, with interstitial space.
- Cathodic protection against external corrosion, and electrical isolation.
- Accessories
    - Leak detection system to UL 1238
    - Automatic tank contents gauge in accordance with UL 180, to provide:
        - Level measurement
            - Class C - (max permissible error ± 1% of measuring range)
        - Water detection
        - Temperature measurement
    - Drain valves.

- Install one piece bronze ball valve with hose end connection at low points in fuel oil piping.

- Filling pipes and connections.
- Vent pipes.
- Outlet valves and pipes.
- Oil return pipes.
- Pressure relief valve
  - Install pressure relief valves in distribution piping between supply and return lines.
- Manual air vents
  - Install manual air vents at high points in fuel oil piping.
- Inlet valve box.
  - Including Fill box
  - Including Locable Fill box
  - Including Spill-Containment Fill box
- Manual shut-off valve
  - Install manual fuel-oil shutoff valves on branch connections to fuel-oil appliance.
- High level alarm.
- Overfill prevention device to be complete with closure device to automatically stop the delivery, preventing the liquid level in the tank exceeding a final closure level.
- Overflow warning pipe.
- Level float switch.
- Containment sump.
  - Fiberglass or PE with sump base, add-on extension pieces as required, sump top, lid, and gasket-seal joints. Include sump entry boots for pipe penetrations through sidewalls.
- Ladder

300.060 OIL LEVEL INDICATORS AND AUTOMATIC TANK CONTENTS GAUGES:

- Automatic tank contents gauge in accordance with UL 180, to provide:
  - Level measurement
    - Class C - (max permissible error ± 1% of measuring range)
  - Water detection
  - Temperature measurement
- Type
  - Float gauge - consisting of float attached to cable, chain, rod or metal tape passing through tank top.
  - Float gauge - consisting of float imparting a movement to magnetic coupling.
  - Hydrostatic type - sealed.
  - Electronic gauge.
  - Mounting
    - Centre end - horizontal cylinders.
    - Centre side or end - rectangular or vertical cylinders.
    - Centre line fitting on side of horizontal cylinder.
    - Centre mounted - side swing float arm where space is restricted.

- Top or bottom.
- Top mounting incorporating extended float pivot.

- Ancillaries
  - Mild steel mounting flanges.
  - Bell.
  - Buzzer.
  - Muting switch.
  - Intrinsically safe relay.
  - Wall box.
  - Warning or signal light.
  - Treated for corrosive situations.
  - Remote indicator with cable.
  - Selector switches for multi-tank installations.
  - Electronic switching units.
  - Power unit - Input single-phase AC 110-240 volts.
  - Power unit - Input single-phase DC 12-240 volts.
  -

300.070 FIRE VALVE SYSTEMS AND THEIR INSTALLATION:

- Standards
  - Comply with NFPA 30.
- Hold open the automatically operated quick closing valve by one of the following methods:
  - by means of tension of wire on which are one or more fusible links.
  - electrically; operated by one or more heat-sensitive devices.
  - pneumatically; the air system sealed by one or more fusible plugs.
  - by means of a sealed system incorporating a sensitive phial placed over firing point.
- Refer to section W60 for BMS interface requirements.

300.080 FUEL OIL DISTRIBUTION PIPING:

- Fuel oil distribution piping and joints and fittings should conform to NFPA 30 and ASTM standards.
  - Black Steel pipes to ASTM A53

300.085 LEAK DETECTION SYSTEM:

  - Relevant parts of UL 1238
- Supply and install a leak detection system in the fuel oil storage/distribution system. Link the system to an integral alarm system.
- Install an automatic shut-off system to ensure no further fuel oil is delivered.

300.090 SCREEN FILTERS:

- Body - Mild steel.
- Filter screen
  - Steel frame with stainless steel filtering medium.

- Ancillaries
    - Differential pressure gauge.
    - Matching flanges.
    - Drain valve.

300.100 SINGLE FILTERS:

- Material
    - Body
        - Cast stainless steel.
        - Cast stainless steel, jacketed.
    - Filter basket - 316 Stainless steel
- Connections
    - Screwed,.
    - Steel, flanged

300.120 CARTRIDGE TYPE STRAINERS:

- Duty
    - Supply cartridge type strainers on oil meters.

300.130 Y TYPE STRAINERS:

- Details
    - Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
    - Cold woeking pressure: 960 kPa.

300.140 OIL METERS:

- Provide volumetric rotary-piston meters.
- Material
    - Meter
        - Brass
        - Anodised aluminium alloy
    - Working chamber
        - Brass
        - Bronze
- Ancillaries
    - Batching unit
    - Percentage flow indicator
    - Remote total indicator
    - Combined rate of flow and total indicator

300.150 CATHODIC PROTECTION OF BURIED METALLIC TANKS:

- Cathodic protection of buried metallic tanks and related piping to be provided in accordance with electrical specifications.

300.160 FUEL PUMPS:

- Description: Comply with UL 343, and HI M109.
- Motor operating conditions
  - Standard operating conditions - reference Y92.2010A
- Surge suppressors
  - Manufacturer fitted - reference Y92.1040#
- Motor type
  - Induction (asynchronous).
  - Asynchronous induction with VSD.
- Standards - reference Y92.1010
- General - reference Y92.2020
  - Provide protected enclosures against external mechanical impacts in accordance with BS EN 62262
    - IK08.
- Motor efficiency
  - For VSD motors: Efficiency class IE2, reference Y92.2025A;
  - For constant speed motors: Efficiency class IE3, reference Y92.20205B
- Degree of protection in accordance with BS EN 60034-5
  - IP55
- Method of motor cooling in accordance with BS EN 60034-6, reference Y92.2020
- Motors - over temperature protection
  - Thermistors - reference Y92.2060A
- Guards -Reference Y92.2090A
- Accessories
  - Casing thermal insulation.
- Valves and fittings
  - Provide isolation valves on suction and discharge side of pumps.
  - Provide non-return valves on discharge side of each pump.
  - Provide pressure gauge in discharge manifold.
  - Alarms and indication
- Audiable alarm is not required when there is a BMS interface for the Pumps.
  - For interface points to the BMS, refer to BMS control diagrams and specs.
  - Pump run and trip for each pump.
  - Low water cut off.

- Control panel
    - Factory installed and connected as an integral part of unit.
    - Panel IP rating 55
- Accessories
    - Additional control module to provide surge protection on start-up or when power is restored by allowing only one pump to be enabled and pulsed for a pre-set time until a pre-set pressure is reached.
    - Combined anti-vacuum, automatic air vent and surge protection valve supplied loose for fitting at top of risers

310.000 WORKMANSHIP

310.005 GENERAL SAFETY REQUIREMENTS AND TESTS:

- As appropriate to the particular project, comply with the requirements of NFPA 30 for the safety and corresponding tests for plant, equipment and pipework within an oil supply installation to burners.

310.010 INSTALLATION OF OIL STORAGE TANKS:

- Install oil storage tanks in accordance with the following as applicable:
    - The requirements of NFPA 30 and the manufacturer's recommendations.

310.020 INSTALLATION OF OIL DISTRIBUTION SYSTEMS:

- Install oil distribution systems in accordance with equipment manufacturers' recommendations, the standards and relevant legislation listed in clause 300.005.

310.030 INSTALLATION OF PUMPS:

- General - reference Y20.4010
- Pipeline connections - reference Y20.4020
- Alignment - reference Y20.4040
- Access - reference Y20.4050
- Install test and commission systems to comply with equipment manufacturer's recommendations, and NFPA 30.

S60 - FIRE HOSE REELS

PART 3 SPECIFICATION CLAUSES SPECIFIC TO S60

300.000 GENERAL

300.010 SUMMARY

- Section Includes:
    - Fire protection cabinets for the following:
        - Portable fire extinguishers.
        - Fire hose valves.
        - Fire hoses and racks.
        - Fire hose reels.

300.020 QUALITY ASSURANCE

- Fire-Rated, Fire Protection Cabinets: Listed and labeled to comply with requirements in ASTM E 814 for fire-resistance rating of walls where they are installed.
- Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- Preinstallation Conference: Conduct conference at Project site.
    - Review methods and procedures related to fire protection cabinets including, but not limited to, the following:
        - Schedules and coordination requirements.

- COORDINATION
    - Coordinate size of fire protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
    - Coordinate size of fire protection cabinets to ensure that type and capacity of fire hoses, hose valves, and hose racks indicated are accommodated.
    - Coordinate sizes and locations of fire protection cabinets with wall depths.

310.000 PRODUCTS/MATERIALS

310.010 MATERIALS

- Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.
- Tempered Float Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1 (clear).

310.020 FIRE PROTECTION CABINET LVC-1

- Cabinet Type: Suitable for fire hose valve.

- Cabinet Construction: Nonrated for surface mounted cabinets and 1 or 2-hour fire rated as applicable to match wall fire rating as whown on Drawings.

    - Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 1.1-mm-thick, cold-rolled steel sheet lined with minimum 16-mm- thick, fire-barrier material. Provide factory-drilled mounting holes.

- Cabinet Material: Steel sheet.

    - Shelf: Same metal and finish as cabinet.

- Recessed Cabinet: Cabinet box recessed in walls of sufficient depth to suit style of trim indicated.

    - Trimless with Concealed Flange: Surface of surrounding wall finishes flush with exterior finished surface of cabinet frame and door, without overlapping trim attached to cabinet. Provide recessed flange, of same material as box, attached to box to act as plaster stop.

- Semirecessed Cabinet: Cabinet box partially recessed in walls of sufficient depth to suit style of trim indicated; with one-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend). Provide where walls are of insufficient depth for recessed cabinets but are of sufficient depth to accommodate semirecessed cabinet installation.

    - Square-Edge Trim: 32- to 38-mm backbend depth.
    - Rolled-Edge Trim: 64-mm backbend depth.

- Surface-Mounted Cabinet: Cabinet box fully exposed and mounted directly on wall with no trim. Provide where walls are of insufficient depth for semirecessed cabinet installation.

- Cabinet Trim Material: Steel sheet.

- Door Material: Steel sheet.

- Door Style: Center glass panel with frame.

- Door Glazing: Tempered float glass (clear).

- Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.

    - Provide recessed door pull and friction latch.
    - Provide concealed hinge permitting door to open 180 degrees.

- Accessories:
    - Lettered Door Handle: One-piece, cast-iron door handle with the word "FIRE" embossed into face.
    - Door Lock: Cam lock that allows door to be opened during emergency by pulling sharply on door handle.
    - Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as directed by Engineer.

- Alarm: Manufacturer's standard alarm that actuates when fire protection cabinet door is opened and that is powered by batteries.

- Finishes:

  - Manufacturer's standard baked-enamel paint for the following:

    - Exterior of cabinet, door, and trim except for those surfaces indicated to receive another finish.
    - Interior of cabinet and door.

  - Steel: Baked enamel or powder coat.

310.030 FIRE PROTECTION CABINET FHC-1

- Cabinet Type: Suitable for fire hose valve, fire hose reel, and fire extingusher.

- Cabinet Construction: Nonrated for surface mounted cabinets and 1 or 2-hour fire rated as applicable to match wall fire rating as whown on Drawings.

  - Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 1.1-mm-thick, cold-rolled steel sheet lined with minimum 16-mm- thick, fire-barrier material. Provide factory-drilled mounting holes.

- Cabinet Material: Steel sheet.

  - Shelf: Same metal and finish as cabinet.

- Recessed Cabinet: Cabinet box recessed in walls of sufficient depth to suit style of trim indicated.

  - Trimless with Concealed Flange: Surface of surrounding wall finishes flush with exterior finished surface of cabinet frame and door, without overlapping trim attached to cabinet. Provide recessed flange, of same material as box, attached to box to act as plaster stop.

- Semirecessed Cabinet: Cabinet box partially recessed in walls of sufficient depth to suit style of trim indicated; with one-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend). Provide where walls are of insufficient depth for recessed cabinets but are of sufficient depth to accommodate semirecessed cabinet installation.

  - Square-Edge Trim: 32- to 38-mm backbend depth.
  - Rolled-Edge Trim: 64-mm backbend depth.

- Surface-Mounted Cabinet: Cabinet box fully exposed and mounted directly on wall with no trim. Provide where walls are of insufficient depth for semirecessed cabinet installation.

- Cabinet Trim Material: Steel sheet.

- Door Material: Steel sheet.

- Door Style: Center glass panel with frame.

- Door Glazing: Tempered float glass (clear).

- Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.

    - Provide recessed door pull and friction latch.
    - Provide concealed hinge permitting door to open 180 degrees.

- Accessories:

    - Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
    - Lettered Door Handle: One-piece, cast-iron door handle with the word "FIRE" embossed into face.
    - Door Lock: Cam lock that allows door to be opened during emergency by pulling sharply on door handle.
    - Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as directed by Engineer.

        - Identify fire extinguisher in fire protection cabinet with the words "FIRE EXTINGUISHER."

            - Location: Applied to cabinet door.
            - Application Process: Pressure-sensitive vinyl letters.
            - Lettering Color: Red.
            - Orientation: Vertical or Horizontal.

    - Alarm: Manufacturer's standard alarm that actuates when fire protection cabinet door is opened and that is powered by batteries.

- Finishes:

    - Manufacturer's standard baked-enamel paint for the following:

        - Exterior of cabinet, door, and trim except for those surfaces indicated to receive another finish.
        - Interior of cabinet and door.

    - Steel: Baked enamel or powder coat.

310.040 FABRICATION

- Fire Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.

    - Weld joints and grind smooth.
    - Provide factory-drilled mounting holes.
    - Prepare doors and frames to receive locks.
    - Install door locks at factory.

- Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.

    - Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 13 mm thick.

- Miter and weld perimeter door frames.

- Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

310.050 GENERAL FINISH REQUIREMENTS

- Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

- Protect mechanical finishes on exposed surfaces of fire protection cabinets from damage by applying a strippable, temporary protective covering before shipping.

- Finish fire protection cabinets after assembly.

- Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

310.060 STEEL FINISHES

- Surface Preparation: Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning" or SSPC-SP 8, "Pickling". After cleaning, apply a conversion coating suited to the organic coating to be applied over it.

- Factory Prime Finish: Apply manufacturer's standard, fast-curing, lead- and chromate-free, universal primer immediately after surface preparation and pretreatment.

- Baked-Enamel or Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 0.05 mm.

    - Color and Gloss: As selected by Engineer from manufacturer's full range.

320.000 WORKMANSHIP

320.010 EXAMINATION

- Examine roughing-in for hose valves, racks, and reels and cabinets to verify actual locations of piping connections before cabinet installation.

- Examine walls and partitions for suitable framing depth and blocking where recessed and semirecessed cabinets will be installed.

- Proceed with installation only after unsatisfactory conditions have been corrected.

320.020 PREPARATION

- Prepare recesses for recessed and semirecessed fire protection cabinets as required by type and size of cabinet and trim style.

320.030 INSTALLATION

- General: Install fire protection cabinets in locations and at mounting heights indicated or, if not indicated, at heights indicated below:
    - Fire Protection Cabinets: 1372 mm above finished floor to top of cabinet.
- Fire Protection Cabinets: Fasten cabinets to structure, square and plumb.
    - Unless otherwise indicated, provide recessed fire protection cabinets. If wall thickness is not adequate for recessed cabinets, provide semirecessed fire protection cabinets.
    - Provide inside latch and lock for break-glass panels.
    - Fasten mounting brackets to inside surface of fire protection cabinets, square and plumb.
    - Fire-Rated, Hose-Valve Cabinets and Hose Reel Cabinets:
        - Install cabinet with not more than 1.6-mm tolerance between pipe OD and knockout OD. Center pipe within knockout.
        - Seal through penetrations with firestopping sealant as specified in architectural specification sections
- Identification: Apply vinyl lettering at locations indicated.

320.040 ADJUSTING AND CLEANING

- Remove temporary protective coverings and strippable films, if any, as fire protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.
- Adjust fire protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
- On completion of fire protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
- Touch up marred finishes, or replace fire protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire protection cabinet and mounting bracket manufacturers.
- Replace fire protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

S62 - WET RISERS

100.000 GENERAL

100.010 SYSTEM PERFORMANCE REQUIREMENTS

- Verify the design of standpipes for compliance with NFPA, and obtain approval from Engineer and authorities having jurisdiction. Include minimum residual pressures at hydraulically remote outlets according to the following:

  - DN40 (NPS 1-1/2) Hose Connections: 450 kPa (65 psig).
  - DN65 (NPS 2-1/2) Hose Connections: 690 kPa (100 psig).

- Components and Installation: Capable of producing piping systems with 1200-kPa (175-psig) minimum working-pressure rating, unless otherwise indicated.

- Seismic Performance: Fire-suppression standpipes shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.

100.020 QUALITY ASSURANCE

- Installer Qualifications: An experienced installer who has designed, installed and obtained approvals for fire-suppression piping similar to that indicated for this Project.

- Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer. Base calculations on results of fire-hydrant flow test.

- Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of fire-suppression piping that are similar to those indicated for this Project in material, design, and extent.

- Manufacturer Qualifications: Firms whose equipment, specialties, and accessories are listed by product name and manufacturer in UL's "Fire Protection Equipment Directory" and FM's "Fire Protection Approval Guide" and that comply with other requirements indicated.

- Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code Section IX.

- Standpipe Components: Listing/approval stamp, label, or other marking by a testing agency acceptable to Engineer and authorities having jurisdiction.

- Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to Engineer.

- NFPA Standard: Equipment, specialties, accessories, installation, and testing complying with NFPA 14, "Standpipe and Hose Systems."

200.000 PRODUCTS

200.010 SYSTEM DESCRIPTIONS

- Automatic Wet-Type, Class I Standpipe System: Includes NPS 2-1/2 (DN 65) hose connections. Has open water-supply valve with pressure maintained and is capable of supplying water demand.

- Automatic Wet-Type, Class III Standpipe System: Includes NPS 1-1/2 (DN 40) hose stations and NPS 2-1/2 (DN 65) hose connections. Has open water-supply valve with pressure maintained and is capable of supplying water demand.

200.020 PIPES

- Ductile-Iron Pipe: AWWA C151, push-on-joint type; with cement-mortar lining and seal coat according to AWWA C104. Include rubber gasket according to AWWA C111.

- Ductile-Iron Pipe: AWWA C151, mechanical-joint type; with cement-mortar lining and seal coat according to AWWA C104. Include gland, rubber gasket, and bolts and nuts according to AWWA C111.

- Ductile-Iron Pipe: AWWA C115 or AWWA C151, with cement-mortar lining and seal coat according to AWWA C104 and ends factory or field, radius-cut grooved according to AWWA C606.

- Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135/A 135M, or ASTM A 795/A 795M; Schedule 40 in DN150 (NPS 6) and smaller, and Schedule 30 in DN200 (NPS 8) and larger.

- Schedule 30 Steel Pipe: ASTM A 135/A 135M or ASTM A 795/A 795M, with wall thickness less than Schedule 40 and equal to or greater than Schedule 30 or ASTM A 795/A 795M and ASME B36.10M, Schedule 30 wrought-steel pipe.

200.030 PIPE FITTINGS

- Ductile-Iron Fittings: AWWA C110, ductile-iron or cast-iron type; or AWWA C153, ductile-iron, compact mechanical-joint type. Include cement-mortar lining and seal coat according to AWWA C104 and glands, rubber gaskets, and bolts and nuts according to AWWA C111.

- Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron or ASTM A 536, ductile-iron casting complying with AWWA pipe size; with ends factory grooved according to AWWA C606.

- Cast-Iron Threaded Flanges: ASME B16.1.

- Cast-Iron Threaded Fittings: ASME B16.4.

- Malleable-Iron Threaded Fittings: ASME B16.3.

- Steel, Threaded Couplings: ASTM A 865/A 865M.

- Steel Welding Fittings: ASTM A 234/A 234M, ASME B16.9, or ASME B16.11.

- Steel Flanges and Flanged Fittings: ASME B16.5.

- Steel, Grooved-End Fittings: UL-listed and FM-approved, ASTM A 47/A 47M, malleable iron or ASTM A 536, ductile iron; with dimensions matching steel pipe and ends factory grooved according to AWWA C606.

200.040 JOINING MATERIALS

- Ductile-Iron, Keyed Couplings: UL 213 and AWWA C606, for ductile-iron pipe dimensions. Include ASTM A 536, ductile-iron housing, rubber gaskets, and steel bolts and nuts.

- Ductile-Iron, Flanged Joints: AWWA C115, ductile-iron or gray-iron pipe flanges, rubber gaskets, and steel bolts and nuts.

- Steel, Keyed Couplings: UL 213 and AWWA C606, for steel-pipe dimensions. Include ASTM A 536, ductile-iron housing, rubber gaskets, and steel bolts and nuts. Include listing for dry-pipe service for couplings for dry piping.

- Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick.

    - Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
    - Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.

- Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

- Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

200.050 POLYETHYLENE ENCASEMENT

- Polyethylene Encasement for Ductile-Iron Piping: ASTM A 674 or AWWA C105, film, 0.20-mm minimum thickness, tube or sheet.

200.060 FIRE-PROTECTION-SERVICE VALVES

- General: UL listed and FM approved, with minimum 1200-kPa (175-psig) nonshock working-pressure rating. Valves for grooved-end piping may be furnished with grooved ends instead of type of ends specified.

- Gate Valves, DN50 (NPS 2) and Smaller: UL 262; cast-bronze, threaded ends; solid wedge; OS&Y; and rising stem.

- Gate Valves, DN65 (NPS 2-1/2) and Larger: UL 262, iron body, bronze mounted, taper wedge, OS&Y, and rising stem. Include replaceable, bronze, wedge facing rings and flanged ends.

- Swing Check Valves, DN50 (NPS 2) and Smaller: UL 312 or MSS SP-80, Class 150; bronze body with bronze disc and threaded ends.

- Swing Check Valves, DN65 (NPS 2-1/2) and Larger: UL 312, cast-iron body and bolted cap, with bronze disc or cast-iron disc with bronze-disc ring and flanged ends.

- Split-Clapper Check Valves, DN100 (NPS 4) and Larger: UL 312, cast-iron body with rubber seal, bronze-alloy discs, and stainless-steel spring and hinge pin.

200.065 SPECIALTY VALVES

- Deluge Valves: UL 260, cast-iron body, 1200-kPa (175-psig) working pressure; hydraulically operated, differential-pressure type. Include flanged inlet and outlet, bronze seat with O-ring seals, trim sets for bypass, drain, electric sprinkler alarm switch, pressure gages, drip cup assembly piped without valves and separate from main drain line, fill-line attachment with strainer, and push-rod chamber supply connection.

    - Option: Grooved-end connections for use with grooved-end piping.
    - Wet, Pilot-Line Trim Set: Include gage to read push-rod chamber pressure, globe valve for manual operation of deluge valve, and connection for actuation device.

- Pressure-Regulating Valves: UL 1468, 2760-kPa (400-psig) minimum rating, brass. Include DN40 or DN65 (NPS 1-1/2 or NPS 2-1/2), female NPS inlet and outlet; adjustable setting feature; and straight or 90-degree angle pattern design as indicated.

    - Finish: Rough chrome-plated.

- Ball Drip Valves: UL 1726, automatic drain valve, DN20 (NPS 3/4), ball check device with threaded ends.

200.070 MANUAL CONTROL STATIONS

- Manual Control Stations: Hydraulic operation, with union, DN15 (NPS 1/2) pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

200.080 HOSE CONNECTIONS

- Description: UL 668, 2070-kPa (300-psig) minimum pressure rating, brass, hose valve for connection of fire hose. Include 90-degree angle pattern design; female NPS inlet and male hose outlet; and lugged cap, gasket, and chain. Include DN40 or DN65 (NPS 1-1/2 or NPS 2-1/2) as indicated, and hose valve threads according to NFPA 1963 and matching local fire department threads.

    - Valve Operation: Nonadjustable type, unless pressure-regulating type is indicated.
    - Finish: Rough brass.
    - Finish: Rough chrome-plated.

200.085 HOSE STATIONS

- DN65 and DN40 (NPS 2-1/2 and NPS 1-1/2) Hose Stations: DN65 (NPS 2-1/2) hose valve with male threaded outlet, cap, and chain and DN40 (NPS 1-1/2) hose valve; hose rack with water-retention device and pins for folded, DN40 (NPS 1-1/2) lined hose; and DN40 (NPS 1-1/2) lined hose with swivel inlet coupling and nozzle.

    - Hose-Rack Finish: Red enamel.
    - Hose Valve and Trim Finish: Polished chrome-plated.
    - Fire Hose: Lined, 30-m (100-foot) length.
    - Nozzle: Brass, adjustable from shutoff to fog spray or straight stream.

- FIRE DEPARTMENT CONNECTIONS

  - Wall, Fire Department Connections: UL 405; cast-brass body with brass, wall, escutcheon plate; brass, lugged caps with gaskets and brass chains; and brass, lugged swivel connections. Include inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate with marking "STANDPIPE."

    - Type: Flush mounting.
    - Escutcheon Plate: Rectangular.
    - Finish: Polished chrome-plated.

200.090 ALARM DEVICES

- General: Types matching piping and equipment connections.

- Water-Flow Indicators: UL 346; electrical-supervision, vane-type water-flow detector; with 1725-kPa (250-psig) pressure rating; and designed for horizontal or vertical installation. Include two single-pole, double-throw, circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.

- Pressure Switches: UL 753; electrical-supervision-type, water-flow switch with retard feature. Include single-pole, double-throw, normally closed contacts and design that operates on rising pressure and signals water flow.

- Valve Supervisory Switches: UL 753; electrical; single-pole, double throw; with normally closed contacts. Include design that signals controlled valve is in other than fully open position.

- Indicator-Post Supervisory Switches: UL 753; electrical; single-pole, double throw; with normally closed contacts. Include design that signals controlled indicator-post valve is in other than fully open position.

200.095 PRESSURE GAGES

- Pressure Gages: UL 393, 90- to 115-mm diameter dial with dial range of 0 to 1725 kPa (0 to 250 psig).

200.100 CONTROL PANELS

- Description: Single-area, two-area, or single-area cross-zoned type as indicated. Control panel includes NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves. Panels contain power supply; battery charger; standby batteries; field-wiring terminal strip; electrically supervised solenoid valves and polarized fire alarm bell; lamp test facility; single-pole, double-throw auxiliary alarm contacts; and rectifier.

  - Panels: UL listed and FM approved when used with thermal detectors and Class A detector circuit wiring. Electrical characteristics are 220-V ac, 50 Hz, with 24-V dc rechargeable batteries.
  - Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION" with operating instructions and a cover held closed by breakable strut.
  - Manual Control Stations: Hydraulic operation, with union, DN15 (NPS 1/2) pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and a cover held closed by breakable strut.

300.000 EXECUTION

300.010 PREPARATION

- Perform fire-hydrant flow test according to NFPA 291. Use results for system design calculations required in "Quality Assurance" Article in Part 1 of this Section.

- Report test results promptly and in writing.

300.015 EXAMINATION

- Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.

- Examine walls and partitions for suitable thickness, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.

- Proceed with installation only after unsatisfactory conditions have been corrected.

300.020 PIPING APPLICATIONS

- Do not use welded joints with galvanized steel pipe.

- Do not use galvanized or black steel pipes in underground applications.

- Flanges, unions, and transition and special fittings with pressure ratings the same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.

- Piping between Fire Department Connections and Check Valves, and other dry-type fire-suppression standpipe piping: Use galvanized, standard-weight steel pipe with threaded ends; cast- or malleable-iron threaded fittings; and threaded joints.

- Piping between Fire Department Connections and Check Valves, and other dry-type fire-suppression standpipe piping: Use galvanized, standard-weight steel pipe with grooved ends; steel, grooved-end fittings; steel, keyed couplings; and grooved joints.

- Underground Service-Entrance Piping: Use ductile-iron, mechanical-joint pipe and fittings and restrained joints.

- Standpipes: Use the following:

    - DN100 (NPS 4) and Smaller: Standard-weight steel pipe with threaded ends, cast- or malleable-iron threaded fittings, and threaded joints.
    - DN125 and DN150 (NPS 5 and NPS 6): Standard-weight steel pipe with grooved ends; steel, grooved-end fittings; steel, keyed couplings; and grooved joints.
    - DN200 (NPS 8) and Larger: Standard-weight steel pipe with grooved ends; steel, grooved-end fittings; steel, keyed couplings; and grooved joints.

300.025 VALVE APPLICATIONS

- Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
    - Fire-Protection-Service Valves: UL listed and FM approved for applications where required by NFPA 14.
        - Shutoff Duty: Use gate valves.
    - General-Duty Valves: For applications where UL-listed and FM-approved valves are not required by NFPA 14.
        - Shutoff Duty: Use gate, ball, or butterfly valves.
        - Throttling Duty: Use globe, ball, or butterfly valves.

300.030 JOINT CONSTRUCTION

- Ductile-Iron-Piping, Grooved Joints: Use ductile-iron pipe with radius-cut-grooved ends; ductile-iron, grooved-end fittings; and ductile-iron, keyed couplings. Assemble joints with couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.
- Steel-Piping, Grooved Joints: Use Schedule 40 steel pipe with cut or roll-grooved ends and Schedule 30 or thinner steel pipe with roll-grooved ends; steel, grooved-end fittings; and steel, keyed couplings. Assemble joints with couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions. Use gaskets listed for dry-pipe service for dry piping.

300.040 SERVICE-ENTRANCE PIPING

- Connect standpipe piping to water-service piping of size and in location indicated for service entrance to building.
- Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping.

300.045 PIPING INSTALLATION

- Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
    - Deviations from approved working plans for piping require written approval from Engineer and authorities having jurisdiction. File written approval with Engineer before deviating from approved working plans.
- Install underground service-entrance piping according to NFPA 24 and with restrained joints.
- Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

- Install unions adjacent to each valve in pipes DN50 (NPS 2) and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.

- Install flanges or flange adapters on valves, apparatus, and equipment having DN65 (NPS 2-1/2) and larger connections.

- Install drain valves on standpipes.

- Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.

- Install alarm devices in piping systems.

- Hangers and Supports: Comply with NFPA 13 for hanger materials. Install according to NFPA 14.

- Earthquake Protection: Install piping according to NFPA 13 to protect from earthquake damage.

- Install piping with grooved joints according to manufacturer's written instructions. Construct rigid piping joints, unless otherwise indicated.

- Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than DN8 (NPS 1/4) and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

300.050 VALVE INSTALLATION

- Install fire-protection specialty valves, trim, fittings, controls, and specialties according to NFPA 13 and NFPA 14, manufacturer's written instructions, and authorities having jurisdiction.

- Gate Valves: Install fire-protection-service valves supervised-open, located to control sources of water supply except from fire department connections. Provide permanent identification signs indicating portion of system controlled by each valve.

- Valves for Wall Fire Hydrants: Install gate valve with nonrising stem in supply pipe.

- Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water supply sources.

- Deluge Valves: Install in vertical position, in proper direction of flow, in main supply to deluge system.

300.060 HOSE-CONNECTION INSTALLATION

- Install hose connections adjacent to standpipes, unless otherwise indicated.

- Install freestanding hose connections for access and minimum passage restriction.

- Install DN65 (NPS 2-1/2) hose connections with quick-disconnect DN65 to DN40 (NPS 2-1/2 by NPS 1-1/2) reducer adapter and flow-restricting device, unless otherwise indicated.

- Install wall-mounting-type hose connections in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet. Install valves at angle required for connection of fire hose. Refer to Section "Fire-Protection Specialties" for cabinets.

300.065 HOSE-STATION INSTALLATION

- Install DN40 (NPS 1-1/2) hose-station valves with flow-restricting device, unless otherwise indicated.
- Install wall-mounting, rack-type hose stations in cabinets. Include pipe escutcheons, with finish matching valves, inside cabinet where water-supply piping penetrates cabinet. Install valves at angle required for connection of fire hose. Cabinets are specified in Division 10 Section "Fire Extinguisher Cabinets."
- Install hose-reel hose stations on wall with bracket attached to substrate.

300.070 CONNECTIONS

- Connect water-supply piping and standpipes to fire pumps. Include backflow preventers.
- Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.
- Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.
- Connect alarm devices to fire alarm.

300.080 LABELING AND IDENTIFICATION

- Install labeling and pipe markers on equipment and piping according to requirements in NFPA 14 and in Section "Identification for Fire-Suppression Piping and Equipment."

300.090 FIELD QUALITY CONTROL

- Flush, test, and inspect standpipes according to NFPA 14, "System Acceptance" Chapter.
- Replace piping system components that do not pass test procedures and retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.
- Report test results promptly and in writing to Engineer and authorities having jurisdiction.

300.100 COMMISSIONING

- Verify that specialty valves, trim, fittings, controls, and accessories are installed and operate correctly.
- Verify that air compressors and their accessories are installed and operate correctly.
- Verify that specified tests of piping are complete.
- Verify that potable-water supplies have correct types of backflow preventers.
- Verify that hose connections and fire department connections have threads compatible with local fire department equipment.
- Drain dry-type standpipe piping.

- Pressurize and check dry-pipe valve air-pressure maintenance devices and air compressors.
- Fill wet-pipe standpipe piping with water.
- Verify that hose connections are correct type and size.
- Verify that hose stations are correct type and size.
- Energize circuits to electrical equipment and devices.
- Adjust operating controls and pressure settings.
- Coordinate with fire alarm tests. Operate as required.

300.110 DEMONSTRATION

- Demonstrate equipment, specialties and accessories, and train Employer's maintenance personnel to adjust, operate, and maintain standpipes and hoses.

S63 - SPRINKLERS

PART 3 SPECIFICATION CLAUSES SPECIFIC TO S63

300.000 GENERAL

300.010 SUMMARY

- This Section includes fire-suppression sprinklers, piping, and equipment for the following building systems:
    - Wet-pipe, fire-suppression sprinklers, including piping, valves, specialties, and automatic sprinklers.

300.020 DEFINITIONS

- Working Plans: Documents, including drawings, calculations, and material specifications prepared according to NFPA 13 for obtaining approval from Engineer and authorities having jurisdiction.
- High-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure higher than standard 175 psig (1200 kPa), but not higher than 300 psig (2070 kPa).
- Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig (1200 kPa) maximum.

300.030 SYSTEM DESCRIPTIONS

- Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.
- Deluge Sprinkler System: Open sprinklers are attached to piping connected to water supply through deluge valve. Fire-detection system, in same area as sprinklers, opens valve. Water flows into piping system and discharges from attached sprinklers when valve opens.

300.040 SYSTEM PERFORMANCE REQUIREMENTS

- Verify the design of sprinklers for conformance with NFPA 13, and obtain approval from Engineer and authorities having jurisdiction.
- Verify the design of sprinkler piping according to the following and obtain approval from Engineer and authorities having jurisdiction:
    - Include 10 percent margin of safety for available water flow and pressure.
    - Include losses through water-service piping, valves, and backflow preventers.
    - Sprinkler Occupancy Hazard Classifications: As per NFPA 13 requirements.
    - Minimum Density for Automatic-Sprinkler Piping Design: As follows:

- Residential (Dwelling) Occupancy: 3.15 mL/s over 37.2-sq. m (0.05 gpm over 400-sq. ft.) area.
- Light-Hazard Occupancy: 6.3 mL/s over 139-sq. m (0.10 gpm over 1500-sq. ft.) area.
- Ordinary-Hazard, Group 1 Occupancy: 9.5 mL/s over 139-sq. m (0.15 gpm over 1500-sq. ft.) area.
- Ordinary-Hazard, Group 2 Occupancy: 12.6 mL/s over 139-sq. m (0.20 gpm over 1500-sq. ft.) area.
- Extra-Hazard, Group 1 Occupancy: 18.9 mL/s over 232-sq. m (0.30 gpm over 2500-sq. ft.) area.
- Extra-Hazard, Group 2 Occupancy: 25.2 mL/s over 232-sq. m (0.40 gpm over 2500-sq. ft.) area.

- Minimum Density for Deluge-Sprinkler Piping Design: As follows:

  - Ordinary-Hazard, Group 1 Occupancy: 9.5 mL/s (0.15 gpm) over entire area.
  - Ordinary-Hazard, Group 2 Occupancy: 12.6 mL/s (0.20 gpm) over entire area.
  - Extra-Hazard, Group 1 Occupancy: 18.9 mL/s (0.30 gpm) over entire area.
  - Extra-Hazard, Group 2 Occupancy: 25.2 mL/s (0.40 gpm) over entire area.

- Maximum Protection Area per Sprinkler: As per NFPA 13 requirements.

- Components and Installation: Capable of producing piping systems with 1200-kPa (175-psig) minimum working-pressure rating, unless otherwise indicated.

- Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and.

300.050 QUALITY ASSURANCE

- Installer Qualifications: An experienced installer who has designed, installed and obtained approvals for fire-suppression piping similar to that indicated for this Project.

- Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer. Base calculations on results of fire-hydrant flow test.

- Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of fire-suppression piping that are similar to those indicated for this Project in material, design, and extent.

- Manufacturer Qualifications: Firms whose equipment, specialties, and accessories are listed by product name and manufacturer in UL's "Fire Protection Equipment Directory" and FM's "Fire Protection Approval Guide" and that comply with other requirements indicated.

- Sprinkler Components: Listing/approval stamp, label, or other marking by a testing agency acceptable to Engineer and authorities having jurisdiction.

- Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to Engineer.

- NFPA Standards: Equipment, specialties, accessories, installation, and testing complying with the following:

  - NFPA 13, "Installation of Sprinkler Systems."

- NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."
- NFPA 230, "Standard for the Fire Protection of Storage."

300.060 EXTRA MATERIALS

- Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

    - Sprinkler Cabinets: Finished, wall-mounting steel cabinet and hinged cover, with space for a minimum of six spare sprinklers plus sprinkler wrench. Include the number of sprinklers required by NFPA 13 and wrench for sprinklers. Include separate cabinet with sprinklers and wrench for each type of sprinkler on Project.

310.000 MATERIALS / PRODUCTS

310.010 PIPES

- Ductile-Iron Pipe: AWWA C151, push-on-joint type; with cement-mortar lining and seal coat according to AWWA C104. Include rubber gasket according to AWWA C111.

- Ductile-Iron Pipe: AWWA C151, mechanical-joint type; with cement-mortar lining and seal coat according to AWWA C104. Include gland, rubber gasket, and bolts and nuts according to AWWA C111.

- Ductile-Iron Pipe: AWWA C115 or AWWA C151, with cement-mortar lining and seal coat according to AWWA C104 and ends factory or field, radius-cut grooved according to AWWA C606.

- Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135/A 135M, or ASTM A 795/A 135M hot-dip galvanized-steel pipe where indicated; Schedule 40 in DN150 (NPS 6) and smaller, and Schedule 30 in DN200 (NPS 8) and larger.

- Schedule 30 Steel Pipe: ASTM A 135/A 135M or ASTM A 795/A 795M hot-dip galvanized-steel pipe where indicated, with wall thickness less than Schedule 40 and equal to or greater than Schedule 30 or ASTM A 795/A 795M and ASME B36.10M, Schedule 30 wrought-steel pipe.

310.020 PIPE FITTINGS

- Ductile-Iron Fittings: AWWA C110, ductile-iron or cast-iron type; or AWWA C153, ductile-iron, compact mechanical-joint type. Include cement-mortar lining and seal coat according to AWWA C104 and glands, rubber gaskets, and bolts and nuts according to AWWA C111.

- Ductile-Iron Fittings: ASTM A 47/A 47M, malleable-iron or ASTM A 536, ductile-iron casting complying with AWWA pipe size; with ends factory grooved according to AWWA C606.

- Cast-Iron Threaded Flanges: ASME B16.1.

- Cast-Iron Threaded Fittings: ASME B16.4.

- Malleable-Iron Threaded Fittings: ASME B16.3.

- Steel, Threaded Couplings: ASTM A865/A865M.

- Steel Welding Fittings: ASTM A 234/A 234M, ASME B16.9, or ASME B16.11.

- Steel Flanges and Flanged Fittings: ASME B16.5.

- Steel, Grooved-End Fittings: UL-listed and FM-approved, ASTM A 47/A 47M, malleable iron or ASTM A 536, ductile iron; with dimensions matching steel pipe and ends factory grooved according to AWWA C606.

- Steel, Press-Seal Fittings: UL 213 and FM-approved, 1200-kPa (175-psig) pressure rating; with steel housing, butylene O-rings, and pipe stop; for use with Schedule 5, plain-end, steel pipe. Include manufacturer's pressure-sealing tools.

310.030 JOINING MATERIALS

- Ductile-Iron, Keyed Couplings: UL 213 and AWWA C606, for ductile-iron pipe dimensions. Include ASTM A 536, ductile-iron housing, rubber gaskets, and steel bolts and nuts.

- Ductile-Iron, Flanged Joints: AWWA C115, ductile-iron or gray-iron pipe flanges, rubber gaskets, and steel bolts and nuts.

- Steel, Keyed Couplings: UL 213 and AWWA C606, for steel-pipe dimensions. Include ASTM A 536, ductile-iron housing, rubber gaskets, and steel bolts and nuts.

- Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick.

    - Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
    - Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.

- Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

- Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

310.040 POLYETHYLENE ENCASEMENT

- Polyethylene Encasement for Ductile-Iron Piping: ASTM A 674 or AWWA C105, film, 0.20-mm minimum thickness, tube or sheet.

310.050 FIRE-PROTECTION-SERVICE VALVES

- General: UL listed and FM approved, with minimum 1200-kPa (175-psig) nonshock working-pressure rating. Valves for grooved-end piping may be furnished with grooved ends instead of type of ends specified.

- Gate Valves, DN50 (NPS 2) and Smaller: UL 262; cast-bronze, threaded ends; solid wedge; OS&Y; and rising stem.

- Indicating Valves, DN65 (NPS 2-1/2) and Smaller: UL 1091; butterfly or ball-type, bronze body with threaded ends; and integral indicating device.

- Gate Valves, DN65 (NPS 2-1/2) and Larger: UL 262, iron body, bronze mounted, taper wedge, OS&Y, and rising stem. Include replaceable, bronze, wedge facing rings and flanged ends; and integral indicating device.

- Indicating Device: Electrical 220-V ac, prewired, single-circuit, supervisory switch.

- Swing Check Valves, DN50 (NPS 2) and Smaller: UL 312 or MSS SP-80, Class 150; bronze body with bronze disc and threaded ends.

- Swing Check Valves, DN65 (NPS 2-1/2) and Larger: UL 312, cast-iron body and bolted cap, with bronze disc or cast-iron disc with bronze-disc ring and flanged ends.

- Split-Clapper Check Valves, DN100 (NPS 4) and Larger: UL 312, cast-iron body with rubber seal, bronze-alloy discs, and stainless-steel spring and hinge pin.

310.060 SPECIALTY VALVES

- General Requirements:

    - Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
    - Pressure Rating:

        - Standard-Pressure Piping Specialty Valves: 175 psig (1200 kPa) minimum.
        - High-Pressure Piping Specialty Valves: 250 psig (1725 kPa) minimum.

    - Body Material: Cast or ductile iron.
    - Size: Same as connected piping.
    - End Connections: Flanged or grooved.

- Alarm Check Valves: UL 193, 1200-kPa (175-psig) working pressure, designed for horizontal or vertical installation, with cast-iron flanged inlet and outlet, bronze grooved seat with O-ring seals, and single-hinge pin and latch design. Include trim sets for bypass, drain, electric sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.

    - Option: Grooved-end connections for use with keyed couplings.
    - Drip Cup Assembly: Pipe drain without valves, and separate from main drain piping.
    - Drip Cup Assembly: Pipe drain with check valve to main drain piping.

- Zone/Floor Control Valves:

    - Floor control valves assembly consisting of UL listed FM approved indicating-type floor control valve with supervisory switch, pressure gauge, water flow switch , test drain valve assembly and check valve; installation and piping arrangement to be as per NFPA 13 appendix A
    - Floor control valves rated for minimum of 1200 Pa (175psi) working pressure
    - Check valve is optional: check valve is used when valve is connected to combined sprinklers/ stand by riser; if separate risers check valve may not be installed as per NFPA 13 appendix A.
    - Floor control valve shall be provided with a drain connection having a minimum size as determined in NFPA 13 to drain that portion of the system controlled by the sectional valve.
    - A pressure gauge with a connection not smaller than 1⁄4 in. (6 mm) shall be installed at each main drain associated with a floor control valve.

- Floor control valves, should be accessible to authorized persons during emergencies.

- Deluge Valves: UL 260, cast-iron body, 1200-kPa (175-psig) working pressure; hydraulically operated, differential-pressure type. Include flanged inlet and outlet, bronze seat with O-ring seals, trim sets for bypass, drain, electric sprinkler alarm switch, pressure gages, drip cup assembly piped without valves and separate from main drain line, fill-line attachment with strainer, and push- rod chamber supply connection.

  - Option: Grooved-end connections for use with grooved-end piping.
  - Wet, Pilot-Line Trim Set: Include gage to read push-rod chamber pressure, globe valve for manual operation of deluge valve, and connection for actuation device.
  - Dry, Pilot-Line Trim Set: Include dry, pilot-line actuator; air- and water-pressure gages; low-air-pressure warning switch; air- relief valve; and actuation device. Dry, pilot-line actuator includes cast-iron, 1200-kPa (175-psig) working-pressure, air- operated, diaphragm-type valve with resilient facing plate, resilient diaphragm, and replaceable bronze seat. Valve includes threaded water and air inlets and water outlet. Loss of air pressure on dry, pilot-line side allows pilot-line actuator to open and causes deluge valve to open immediately.

- Pressure-Regulating Valves: UL 1468, 2760-kPa (400-psig) minimum rating, brass. Include DN40 or DN65 (NPS 1-1/2 or NPS 2-1/2), female NPS inlet and outlet; adjustable setting feature; and straight or 90-degree angle pattern design as indicated.

  - Finish: Rough chrome-plated.

- Ball Drip Valves: UL 1726, automatic drain valve, DN20 (NPS 3/4), ball check device with threaded ends.

310.070 SPRINKLERS

- General Requirements:

  - Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
  - Pressure Rating for Residential Sprinklers: 175 psig (1200 kPa) maximum.
  - Pressure Rating for Automatic Sprinklers: 175 psig (1200 kPa) minimum.
  - Pressure Rating for High-Pressure Automatic Sprinklers: 250 psig (1725 kPa) minimum.

- Automatic Sprinklers: With heat-responsive element complying with the following:

  - UL 199, for applications except residential.
  - UL 1626, for residential applications.
  - UL 1767, for early suppression, fast-response applications.

- Sprinkler Types and Categories: Nominal 12.7-mm (1/2-inch) orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.

- Open Sprinklers with Heat-Responsive Element Removed: UL 199.

  - Characteristics:

    - Nominal 1/2-inch (12.7-mm) Orifice: With Discharge Coefficient K between 5.3 and 5.8.
    - Nominal 17/32-inch (13.5-mm) Orifice: With Discharge Coefficient K between 7.4 and 8.2.

- Sprinkler types, features, and options include the following, as shown in the sprinklers schedule on Drawings:

    - Concealed ceiling sprinklers, including cover plate.
    - Extended-coverage sprinklers.
    - Flow-control sprinklers, with automatic open and shutoff feature.
    - Flush ceiling sprinklers, including escutcheon.
    - Institution sprinklers, made with small, breakaway projection.
    - Pendent sprinklers.
    - Quick-response sprinklers.
    - Recessed sprinklers, including escutcheon.
    - Sidewall sprinklers, including escutcheon.
    - Upright sprinklers.

- Sprinkler Finishes: Chrome-plated, bronze, and painted.

- Special Coatings: Wax, lead, and corrosion-resistant paint.

- Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

    - Ceiling Mounting: Chrome-plated steel, one piece, flat.
    - Ceiling Mounting: Chrome-plated steel, two piece, with 25-mm vertical adjustment.
    - Sidewall Mounting: Chrome-plated steel, one piece, flat.

- Sprinkler Guards: UL 199, Wire-cage type, including fastening device for attaching to sprinkler.

310.080 SPECIALTY SPRINKLER FITTINGS

- Specialty Fittings: UL listed and FM approved; made of steel, ductile iron, or other materials compatible with piping.

- Press-Seal Fittings: UL 213, steel housing with butylene O-rings and pipe stop.

- Locking-Lug Fittings: UL 213, ductile-iron body with locking-lug ends.

- Mechanical-T Fittings: UL 213, ductile-iron housing with pressure-responsive gasket, bolts, and threaded or locking-lug outlet.

- Mechanical-Cross Fittings: UL 213, ductile-iron housing with pressure-responsive gaskets, bolts, and threaded or locking-lug outlets.

- Drop-Nipple Fittings: UL 1474, with threaded inlet, threaded outlet, and seals; adjustable.

- Sprinkler, Drain and Alarm Test Fittings: UL-listed, cast- or ductile-iron body; with threaded inlet and outlet, test valve, and orifice and sight glass.

- Sprinkler, Branch-Line Test Fittings: UL-listed, brass body; with threaded inlet and capped drain outlet and threaded outlet for sprinkler.

- Sprinkler, Inspector's Test Fittings: UL-listed, cast- or ductile-iron housing; with threaded inlet and drain outlet and sight glass.

- Flexible Sprinkler Hose Fittings:

- Standard: UL 1474.
- Type: Flexible hose for connection to sprinkler, and with bracket for connection to ceiling grid.
- Pressure Rating: 175-psig (1200-kPa) minimum.
- Size: Same as connected piping, for sprinkler.

310.090 FIRE DEPARTMENT CONNECTIONS

- Wall, Fire Department Connections: UL 405; cast-brass body with brass, wall, escutcheon plate; brass, lugged caps with gaskets and brass chains; and brass, lugged swivel connections. Include inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate with marking "AUTO SPKR."

  - Type: Flush mounting.
  - Escutcheon Plate: Rectangular.
  - Finish: Polished chrome-plated.

310.100 ALARM DEVICES

- General: Types matching piping and equipment connections.

- Water-Motor-Operated Alarms: UL 753, mechanical-operation type with pelton-wheel operator with shaft length, bearings, and sleeve to suit wall construction and 250-mm diameter, cast-aluminum alarm gong with red-enamel factory finish. Include DN20 (NPS 3/4) inlet and DN25 (NPS 1) drain connections.

- Water-Flow Indicators: UL 346; electrical-supervision, vane-type water-flow detector; with 1725-kPa (250-psig) pressure rating; and designed for horizontal or vertical installation. Include two single-pole, double-throw, circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.

- Pressure Switches: UL 753; electrical-supervision-type, water-flow switch with retard feature. Include single-pole, double-throw, normally closed contacts and design that operates on rising pressure and signals water flow.

- Valve Supervisory Switches: UL 346; electrical; single-pole, double throw; with normally closed contacts. Include design that signals controlled valve is in other than fully open position.

- Indicator-Post Supervisory Switches: UL 346; electrical; single-pole, double throw, with normally closed contacts. Include design that signals controlled indicator-post valve is in other than fully open position.

310.110 PRESSURE GAGES

- Pressure Gages: UL 393, 90- to 115-mm diameter dial with dial range of 0 to 1725 kPa (0 to 250 psig).

310.120 CONTROL PANELS

- Description: Single-area, two-area, or single-area cross-zoned type as indicated. Control panel includes NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves. Panels contain power supply; battery charger; standby batteries; field-wiring

terminal strip; electrically supervised solenoid valves and polarized fire alarm bell; lamp test facility; single-pole, double-throw auxiliary alarm contacts; and rectifier.

- Panels: UL listed and FM approved when used with thermal detectors and Class A detector circuit wiring. Electrical characteristics are 220-V ac, 50 Hz, with 24-V dc rechargeable batteries.
- Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION" with operating instructions and a cover held closed by breakable strut.

320.000 WORKMANSHIP

320.010 PREPARATION

- Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article in Part 300.000 of this Section.

- Report test results promptly and in writing.

320.020 PIPING APPLICATIONS

- Do not use welded joints with galvanized steel pipe.

- Do not use galvanized or black steel pipes in underground applications.

- Flanges, unions, and transition and special fittings with pressure ratings the same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.

- Piping between Fire Department Connections and Check Valves: Use galvanized, standard-weight steel pipe with threaded ends; cast- or malleable-iron threaded fittings; and threaded joints.

- Piping between Fire Department Connections and Check Valves: Use galvanized, standard-weight steel pipe with grooved ends; steel, grooved-end fittings; steel, keyed couplings; and grooved joints.

- Sprinkler Feed Mains and Risers: Use the following:

    - DN100 (NPS 4) and Smaller: Standard-weight steel pipe with threaded ends, cast- or malleable-iron threaded fittings, and threaded joints.
    - DN125 and DN150 (NPS 5 and NPS 6): Standard-weight steel pipe with grooved ends; steel, grooved-end fittings; steel, keyed couplings; and grooved joints.

- Wet-Pipe, Sprinkler Branch Piping: Use the following:

    - DN40 (NPS 1-1/2) and Smaller: Standard-weight steel pipe with threaded ends, cast- or malleable-iron threaded fittings, and threaded joints.
    - DN50 (NPS 2): Standard-weight steel pipe with threaded ends, cast- or malleable-iron threaded fittings, and threaded joints.
    - DN65 to DN75 (NPS 2-1/2 to NPS 3): Standard-weight steel pipe with grooved ends; steel, grooved-end fittings; steel, keyed couplings; and grooved joints.
    - DN100 (NPS 4): Standard-weight steel pipe with grooved ends; steel, grooved-end fittings; steel, keyed couplings; and grooved joints.

320.030 VALVE APPLICATIONS

- Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
    - Fire-Protection-Service Valves: UL listed and FM approved for applications where required by NFPA 13.
        - Shutoff Duty: Use gate valves.
    - General-Duty Valves: For applications where UL-listed and FM-approved valves are not required by NFPA 13.
        - Shutoff Duty: Use gate, ball, or butterfly valves.
        - Throttling Duty: Use globe, ball, or butterfly valves.

320.040 JOINT CONSTRUCTION

- Ductile-Iron-Piping, Grooved Joints: Use ductile-iron pipe with radius-cut-grooved ends; ductile-iron, grooved-end fittings; and ductile-iron, keyed couplings. Assemble joints with couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.
- Steel-Piping, Grooved Joints: Use Schedule 40 steel pipe with cut or roll-grooved ends and Schedule 30 or thinner steel pipe with roll-grooved ends; steel, grooved-end fittings; and steel, keyed couplings. Assemble joints with couplings, gaskets, lubricant, and bolts according to coupling manufacturer's written instructions.Press-Seal-Fitting Joints: Use UL-listed tool and procedure and follow fitting manufacturer's written instructions. Include use of specific equipment, pressure-sealing tool, and accessories.
- Locking-Lug-Fitting, Twist-Locked Joints: Follow fitting manufacturer's written instructions.
- Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.
- Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
- Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
- Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
    - Apply appropriate tape or thread compound to external pipe threads.
    - Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

- Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.

- Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

    - Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

320.050 SERVICE-ENTRANCE PIPING

- Connect sprinkler piping to water-service piping of size and in location indicated for service entrance to building.

- Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping.

320.060 PIPING INSTALLATION

- Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.

    - Deviations from approved working plans for piping require written approval from Engineer and authorities having jurisdiction. File written approval with Engineer before deviating from approved working plans.

- Install underground service-entrance piping according to NFPA 24 and with restrained joints.

- Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

- Install unions adjacent to each valve in pipes DN50 (NPS 2) and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.

- Install flanges or flange adapters on valves, apparatus, and equipment having DN65 (NPS 2-1/2) and larger connections.

- Install "Inspector's Test Connections" in sprinkler piping, complete with shutoff valve, sized and located according to NFPA 13.

- Install sprinkler piping with drains for complete system drainage.

- Install sprinkler zone control valves, test assemblies, and drain risers adjacent to sprinkler risers when sprinkler branch piping is connected to sprinkler risers.

- Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.

- Install alarm devices in piping systems.

- Hangers and Supports: Comply with NFPA 13 for hanger materials and installation.

- Earthquake Protection: Install piping according to NFPA 13 to protect from earthquake damage.

- Install piping with grooved joints according to manufacturer's written instructions. Construct rigid piping joints, unless otherwise indicated.

- Install pressure gages on riser or feed main and at each sprinkler test connection. Include pressure gages with connection not less than DN8 (NPS 1/4) and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

320.070 SPECIALTY SPRINKLER FITTING INSTALLATION

- Install specialty sprinkler fittings according to manufacturer's written instructions.

320.080 VALVE INSTALLATION

- Install listed fire-protection specialty valves, trim, fittings, controls, and specialties according to NFPA 13, manufacturer's written instructions, and authorities having jurisdiction.

- Gate Valves: Install listed fire-protection-service valves supervised-open, located to control sources of water supply except from fire department connections. Provide permanent identification signs indicating portion of system controlled by each valve.

- Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water supply sources.

- Specialty Valves:

    - General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
    - Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.
      Deluge Valves: Install in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

320.090 SPRINKLER APPLICATIONS

- General: Use sprinklers according to the following applications:

    - Rooms without Ceilings: Upright and pendent sprinklers, as indicated.
    - Rooms with Suspended Ceilings: Pendent, recessed, flush, and concealed sprinklers, as indicated.
    - Wall Mounting: Sidewall sprinklers.
    - Deluge-Sprinkler Systems: Upright and pendent, open sprinklers.
    - Special Applications: Use extended-coverage, flow-control, and quick-response sprinklers where indicated.
    - Sprinkler Finishes: Use sprinklers with the following finishes:

        - Upright, Pendent, and Sidewall Sprinklers: Chrome-plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.
        - Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
        - Flush Sprinklers: Bright chrome, with painted white escutcheon.

- Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.
- Residential Sprinklers: Dull chrome.

320.100 SPRINKLER INSTALLATION

- Install sprinklers in patterns indicated.
- Install sprinklers in suspended ceilings in center of acoustical panels and tiles.
- Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

320.110 CONNECTIONS

- Connect water-supply piping and sprinklers to fire pumps. Include backflow preventers.
- Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.
- Connect piping to specialty valves, specialties, fire department connections, and accessories.
- Electrical Connections: Power wiring as specified in Electrical specification sections.
- Connect alarm devices to fire alarm.
- Connect excess-pressure pumps to the following piping and wiring:
    - Sprinkler system, hydraulically.
    - Pressure gages and controls, hydraulically.
    - Electrical power system.
    - Alarm device accessories for pump.
    - Fire alarm system.

320.120 LABELING AND IDENTIFICATION

- Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and in Section Z254.

320.130 FIELD QUALITY CONTROL

- Flush, test, and inspect sprinkler piping according to NFPA 13, "Systems Acceptance" Chapter.
- Replace piping system components that do not pass test procedures and retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.
- Report test results promptly and in writing to Engineer and authorities having jurisdiction.

320.140 CLEANING

- Clean dirt and debris from sprinklers.
- Remove and replace sprinklers having paint other than factory finish.

320.150 PROTECTION

- Protect sprinklers from damage until Substantial Completion.

320.160 COMMISSIONING

- Verify that specialty valves, trim, fittings, controls, and accessories are installed and operate correctly.
- Verify that excess-pressure pumps and accessories are installed and operate correctly.
- Verify that specified tests of piping are complete.
- Verify that damaged sprinklers and sprinklers with paint or coating not specified are replaced with new, correct type.
- Verify that sprinklers are correct types, have correct finishes and temperature ratings, and have guards as required for each application.
- Verify that potable-water supplies have correct types of backflow preventers.
- Verify that fire department connections have threads compatible with local fire department equipment.
- Fill wet-pipe sprinkler piping with water.
- Energize circuits to electrical equipment and devices.
- Start and run excess-pressure pumps.
- Adjust operating controls and pressure settings.
- Coordinate with fire alarm tests. Operate as required.

320.170 DEMONSTRATION

- Demonstrate equipment, specialties and accessories, and train Employer's maintenance personnel to adjust, operate, and maintain fire-suppression sprinklers.

S70 - GAS FIRE FIGHTING

PART 3 SPECIFICATION CLAUSES SPECIFIC TO S70

300.000 GENERAL

300.010 SUBMITTALS

- Shop Drawings: Prepare in accordance with requirements of NFPA 2001, to include, but not be limited to, design calculations.

- Delegated-Design Submittal: For clean-agent fire-extinguishing systems indicated to comply with performance and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

300.020 MAINTENANCE MATERIAL SUBMITTALS

- Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Employer.

    - Detection Devices: Not less than 20 percent of amount of each type installed.
    - Container Valves: Not less than 10 percent of amount of each size and type installed.
    - Nozzles: Not less than 20 percent of amount of each type installed.
    - Extinguishing Agent: Not less than 100 percent of amount installed in largest hazard area. Include pressure-rated containers with valves.

300.030 QUALITY ASSURANCE

- Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of clean-agent extinguishing systems that are similar to those indicated for this Project in material, design, and extent.

- Product Options: Drawings indicate size, profiles, and dimensional requirements of clean-agent extinguishing systems and are based on the specific system selected. Other manufacturers' systems with equal performance characteristics may be considered. Refer to Division 1 Section "Product Requirements."

- Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators in accordance with ASME Boiler and Pressure Vessel Code.

- ASME Compliance: Fabricate piping to comply with ASME B31.1, "Power Piping."

- NFPA Compliance: Fabricate and label clean-agent extinguishing systems to comply with NFPA 2001, "Clean Agent Fire Extinguishing Systems."

310.000 PRODUCTS/MATERIALS

310.010 PERFORMANCE REQUIREMENTS

- Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

- FM Global Compliance: Provide components that are FM Approved and that are listed in FM Approvals' "Approval Guide."

- UL Compliance: Provide equipment components complying with UL 1058, "Halogenated Agent Extinguishing System Units," and are UL listed for clean-agent extinguishing system units in UL's "Fire Protection Equipment Directory."

- Seismic Performance: Fire-suppression piping shall withstand the effects of earthquake motions determined in accordance with NFPA 13.

    - The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
    - Component Importance Factor: 1.5.

310.020 CLEAN-AGENT SYSTEMS

- Source Limitations: Obtain clean-agent systems from single source from single manufacturer.

- Description: Clean-agent fire-extinguishing system shall be an engineered system for total flooding of the hazard area including the room cavity above the ceiling, below the ceiling, and below the raised floor. System includes separate zones above and below the ceiling and beneath the raised floor. If smoke is detected below the raised floor, extinguishing agent shall be discharged in the underfloor zone only. If smoke is detected below the ceiling, extinguishing agent shall be discharged in zones above and below the ceiling and below the floor. If smoke is detected above the ceiling, extinguishing agent shall be discharged in the zone above the ceiling only.

- Delegated Design: Design clean-agent fire-extinguishing system and obtain approval from authorities having jurisdiction. Design system for Class A, Class B, or Class C fires as appropriate for areas being protected, and include safety factor. Use clean agent indicated and in concentration suitable for normally occupied areas.

- Performance Requirements: Discharge IG-100 within 60 seconds and maintain 41.9 percent design concentration by volume at 21 deg C for 10-minute holding time in hazard areas.

    - IG-100 concentration in hazard areas greater than 40 percent immediately after discharge or less than 36 percent throughout holding time will not be accepted without written authorization from Employer and authorities having jurisdiction.
    - System Capabilities: Minimum 16.575-MPa calculated working pressure upstream from orifice union, minimum 6895-kPa calculated working pressure downstream from orifice union, and 16.575-MPa initial charging pressure.

- Cross-Zoned Detection: Devices located in two separate zones. Sound alarm on activating single-detection device, and discharge extinguishing agent on actuating single-detection device in another zone.

- Verified Detection: Devices located in single zone. Sound alarm on activating single-detection device, and discharge extinguishing agent on actuating second-detection device.

- System Operating Sequence:

    - Actuating First Detector: Visual indication on annunciator panel. Energize audible and visual alarms (slow pulse), shut down air-conditioning and ventilating systems serving protected area, close doors in protected area, and send signal to fire-alarm system.
    - Actuating Second Detector: Visual indication on annunciator panel. Energize audible and visual alarms (fast pulse), shut down power to protected equipment, start time delay for extinguishing-agent discharge for 30 seconds, and discharge extinguishing agent.
    - Extinguishing-agent discharge will operate audible alarms and strobe lights inside and outside the protected area.

- A pressure relief vent shall be provided where required based on the enclosure test evaluation as per NFPA 2001 & FSSA guide to maintain pressure within specified enclosure pressure limit.

- Manual stations shall immediately discharge extinguishing agent when activated.

- Operating abort switches will delay extinguishing-agent discharge while being activated, and switches must be reset to prevent agent discharge. Release hand pressure on the switch to cause agent discharge after the time delay has expired.

- EPO: Will terminate power to protected equipment immediately on actuation.

- Low-Agent Pressure Switch: Initiate trouble alarm if sensing less than set pressure.

- Power Transfer Switch: Transfer from normal to standby power source.

310.030 PIPE AND FITTINGS

- See "Inert Gas Agent Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

- Piping, Valves, and Discharge Nozzles: Comply with types and standards listed in NFPA 2001, Section "Distribution," for charging pressure of system.

- Steel Pipe: ASTM A53/A53M, Type S, Grade B or ASTM A106/A106M, Grade B; Schedule 40, seamless pipe, unless Schedule 80 or Schedule 160 is indicated.

    - Threaded Fittings:

        - Malleable-Iron Fittings: ASME B16.3, Class 300.
        - Flanges and Flanged Fittings: ASME B16.5, Class 300 unless Class 600 is indicated.
        - Fittings Working Pressure: To match minimum system working pressure.
        - Flanged Joints: Class 300 minimum.

    - Forged-Steel Welding Fittings: ASME B16.11, Class 3000, socket pattern.
    - Steel, Grooved-End Fittings: FM Approved and NRTL listed, ASTM A47/A47M malleable iron or ASTM A536 ductile iron, with dimensions matching steel pipe and ends factory grooved in accordance with AWWA C606.

- Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

- ASME B16.21, nonmetallic, flat, asbestos-free, 3.2-mm- maximum thickness unless thickness or specific material is indicated.

- Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

- Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

- Steel, Keyed Couplings: UL 213, AWWA C606, approved or listed for clean-agent service, and matching steel-pipe dimensions. Include ASTM A536, ductile-iron housing, rubber gasket, and steel bolts and nuts.

310.040 VALVES

- General Valve Requirements:

  - UL listed or FM Approved for use in fire-protection systems.
  - Compatible with type of clean agent used.

- Container Valves: With rupture disc or solenoid and manual-release lever, capable of immediate and total agent discharge and suitable for intended flow capacity.

- Valves in Sections of Closed Piping and Manifolds: Fabricate to prevent entrapment of liquid, or install valve and separate pressure relief device.

- Valves in Manifolds: Check valve; installed to prevent loss of extinguishing agent when container is removed from manifold.

- Selector Valves; To be installed in the supply piping branch for the hazard being protected. Depending on the size of the selector valve, the valve is either threaded in place, or bolted to the piping flanges. Constructed of bronze material, the valve is a pressure differential type that blocks the flow of agent through the piping until it is activated. Valve actuation is accomplished either manually with the manual release lever, or by the pilot Nitrogen Cylinder that is part of the selector valve assembly.

310.050 EXTINGUISHING-AGENT CONTAINERS

- Description: Steel tanks complying with ASME Boiler and Pressure Vessel Code: Section VIII, for unfired pressure vessels. Include minimum working-pressure rating that matches system charging pressure, valve, pressure switch, and pressure gage.

  - Finish: Manufacturer's standard color, enamel or epoxy paint.
  - Manifold:

    - Fabricate with valves, pressure switches, and connections for multiple storage containers, as indicated.
    - Fabricate with valves, pressure switches, selector switch, and connections for main- and reserve-supply banks of multiple storage containers.

  - Storage-Tank Brackets: Factory- or field-fabricated retaining brackets consisting of steel straps and channels; suitable for container support, maintenance, and tank refilling or replacement.

310.060 FIRE-EXTINGUISHING CLEAN AGENT

- IG-100 Clean Agent: Nitrogen inert gas.
    - Source Limitations: Obtain clean agents from single source from single manufacturer.

310.070 DISCHARGE NOZZLES

- Description: Equipment manufacturer's standard one-piece brass or aluminum alloy of type, size, discharge pattern, and capacity required for application.
- Material: Corrosion-resistant metal.
- Stamped with orifice size and type.

310.080 MANIFOLD AND ORIFICE UNIONS

- Description: NRTL-listed device with minimum 15-MPa pressure rating, to control flow and reduce pressure of inert gas in piping.
    - DN 50 and Smaller: Piping assembly with orifice, sized for system design requirements.
    - DN 65 and Larger: Piping assembly with nipple, sized for system design requirements.

310.090 FIRE CONTROL PANELS

- Description: FM Approved or NRTL listed, including equipment and features required for testing, supervising, and operating fire-extinguishing system.
- Power Requirements: 120/240 V ac; with electrical contacts for connection to system components and fire-alarm system, and transformer or rectifier as needed to produce power at voltage required for accessories and alarm devices.
- Enclosure: NEMA ICS 6, Type 1, enameled-steel cabinet.
    - Mounting: Surface.
- Supervised Circuits: Separate circuits for each independent hazard area.
    - Detection circuits equal to required number of zones, or addressable devices assigned to required number of zones.
    - Manual pull-station circuit.
    - Alarm circuit.
    - Release circuit.
    - Abort circuit.
    - EPO circuit.
- Control-Panel Features:
    - Electrical contacts for shutting down fans, activating dampers, and operating system electrical devices.
    - Automatic switchover to standby power at loss of primary power.
    - Storage container, low-pressure indicator.

- Service disconnect to interrupt system operation for maintenance with visual status indication on the annunciator panel.
- Control interface capability with Building Control System, if applicable, and Fire Alarm System for general alarm, control panel fault and cylinder low pressure

- Annunciator Panel: Graphic type showing protected, hazard-area plans, as well as locations of detectors and abort, EPO, and manual stations. Include lamps to indicate device-initiating alarm, electrical contacts for connection to control panel, and stainless steel or aluminum enclosure.

- Standby Power: Sealed, valve-regulated, recombinant lead acid, or Vented, wet-cell pocket, plate nickel cadmium batteries with capacity to operate system for 24 hours and alarm for minimum of 15 minutes. Include automatic battery charger that has a varying charging rate between trickle and high depending on battery voltage, and that is capable of maintaining batteries fully charged. Include manual voltage control, dc voltmeter, dc ammeter, electrical contacts for connection to control panel, automatic transfer switch, and suitable enclosure.

310.100 DETECTION DEVICES

- Description: Comply with NFPA 2001, NFPA 72, and UL 268; 24 V dc, nominal.

- Ionization Detectors: Dual-chamber type, having sampling and referencing chambers, with smoke-sensing element.

- Photoelectric Detectors: LED light source and silicon photodiode receiving element.

- Remote Air-Sampling Detector System: Includes air-sampling pipe network, laser-based photoelectric detector, sample transport fan, and control unit.

  - Pipe Network: CPVC tubing connects control unit with calibrated sampling holes.
  - Smoke Detector: Particle-counting type with continuous laser beam. Sensitivity adjustable to a minimum of four preset values.
  - Sample Transport Fan: Centrifugal type, creating a minimum static pressure of 12.5 Pa at all sampling ports.
  - Control Unit: Multizone unit as indicated on Drawings. Provides same system power supply, supervision, and alarm features as specified for the control panel plus separate trouble indication for airflow and detector problems.

- Signals to the Central Fire-Alarm Control Panel: Any type of local system trouble is reported to central fire-alarm control panel as a composite "trouble" signal. Alarms on each system zone are individually reported to central fire-alarm control panel as separately identified zones.

310.110 MANUAL STATIONS

- Description: Surface FM Approved or NRTL listed, with clear plastic hinged cover, 220-V ac or low-voltage compatible with controls. Include contacts for connection to control panel.

- Manual Release: "MANUAL RELEASE" caption, and red finish. Unit can manually discharge extinguishing agent with operating device that remains engaged until unlocked.

- Abort Switch: "ABORT" caption, momentary contact, with green finish.

- EPO Switch: "EPO" caption, with yellow finish.

310.120 SWITCHES

- Description: FM Approved or NRTL listed, where available, 220-V ac or low-voltage compatible with controls. Include contacts for connection to control panel.

    - Low-Agent Pressure Switches: Pneumatic operation.
    - Power Transfer Switches: Key-operation selector, for transfer of release circuit signal from main supply to reserve supply.
    - Abort Switches: Dead-man type, requiring constant pressure, for delay of system discharge.
    - Door Closers: Magnetic retaining and release device or electrical interlock to cause door operator to drive the door closed.

310.130 ALARM DEVICES

- Description: FM Approved or NRTL listed, low voltage, and surface mounting.

- Bells: Minimum 150-mm diameter.

- Horns: 90 to 94 dBA.

- Strobe Lights: Translucent lens, with "FIRE" or similar caption.

- Oxygen Deficiency Monitor.

    - Sampling Method and Range: Diffusion, zero to 25 percent O_2.
    - 24 V dc.
    - Wall mounted with bracket.
    - Built-in audible alarm 90 dBA.
    - Backlit LCD.
    - 10-year no-calibration sensor.
    - No maintenance required.
    - Signal Outputs: Standard 4- to 20-mA analog.
    - Connections for system control data acquisition system and/or programmable logic controller.
    - Plus or minus 1 percent accuracy of full scale.
    - Operating temperature of minus 40 to plus 50 deg C.

320.000 WORKMANSHIP

320.010 EXAMINATION

- Examine areas and conditions, with Installer present, for compliance with enclosure integrity requirements, installation tolerances, and other conditions affecting performance of the Work in accordance with NFPA 2001.

- Proceed with installation only after unsatisfactory conditions have been corrected.

320.020 INERT GAS NITROGEN GAS (IG-100) AGENT PIPING APPLICATIONS

- Piping between Storage Containers and Orifice Union: Schedule 80, steel pipe; forged-steel welding fittings; and welded joints.

- Flanged pipe and fittings and flanged joints may be used to connect to specialties and accessories and where required for maintenance.
- Fittings Working Pressure: 13.8 MPa minimum.
- Flanged Joints: Class 600 minimum.

- Piping Downstream from Orifice Union: Schedule 80, steel pipe; forged-steel welding fittings; and welded joints.

  - Flanged pipe and fittings and flanged joints may be used to connect to specialties and accessories and where required for maintenance.
  - Fittings Working Pressure: 6900 kPa minimum.
  - Flanged Joints: Class 300 minimum.

320.030 CLEAN-AGENT SYSTEM INSTALLATION

- Install clean-agent containers, piping, and other components level and plumb, in accordance with manufacturers' written instructions.

- Clean-Agent Container Mounting:

  - Install clean-agent containers on cast-in-place concrete equipment bases.

- Grooved Piping Joints: Groove pipe ends in accordance with AWWA C606 dimensions. Assemble grooved-end steel pipe and steel, grooved-end fittings with steel, keyed couplings and lubricant in accordance with manufacturer's written instructions.

- Install pipe and fittings, valves, and discharge nozzles in accordance with requirements listed in NFPA 2001, Section "Distribution."

  - Install valves designed to prevent entrapment of liquid, or install pressure relief devices in valved sections of piping systems.
  - Support piping using supports and methods in accordance with NFPA 13.
  - Install seismic restraints for extinguishing-agent piping systems.
  - Install control panels, detection system components, alarms, and accessories, in accordance with requirements listed in NFPA 2001, Section "Detection, Actuation, and Control Systems," as required for supervised system application.

320.040 PIPING CONNECTIONS

- Drawings indicate general arrangement of piping, fittings, and specialties.

- Where installing piping adjacent to equipment, allow space for service and maintenance.

320.050 ELECTRICAL CONNECTIONS

- Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.

- Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

- Connect electrical devices to control panel and to building's fire-alarm system.

320.060 CONTROL CONNECTIONS

- Install control and electrical power wiring to field-mounted control devices.

320.070 IDENTIFICATION

- Identify system components and equipment. Comply with requirements for identification specified in Section Z254
- Identify piping, extinguishing-agent containers, other equipment, and panels in accordance with NFPA 2001.
- Install signs at entry doors for protected areas to warn occupants that they are entering a room protected with a clean-agent fire-extinguishing system.
- Install signs at entry doors to advise persons outside the room the meaning of horn(s), bell(s), and strobe light(s) outside the protected space.

320.070 FIELD QUALITY CONTROL

- Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- Perform tests and inspections with the assistance of a factory-authorized service representative.
- Tests and Inspections:
    - After installing clean-agent fire-extinguishing system and after electrical circuitry has been energized, test for compliance in accordance with requirements listed in NFPA 2001, Section "Approval of Installation."
    - Clean-agent fire-extinguishing system and associated protected enclosure will be considered defective if either does not pass required tests and inspections.
    - Prepare test and inspection reports in accordance with requirements listed in NFPA 2001, Section "Installation Acceptance."
- Comply with operating instructions and procedures of NFPA 2001, Section "Approval of Installations." Include the following inspections and tests to demonstrate compliance with requirements:
    - Check mechanical items.
    - Inspect extinguishing-agent containers and extinguishing agent, and check mountings for adequate anchoring to substrate.
    - Check electrical systems.
    - Check enclosure integrity. Comply with NFPA 2001, Section "Enclosure Inspection," and Appendix C, "Enclosure Integrity Procedure."
    - Perform functional predischarge test.
    - Perform system functional operational test.
    - Check remote monitoring operations.
    - Check control-panel primary power source.
    - Perform "puff" test on piping system, using nitrogen.
- Perform field-acceptance tests of each clean-agent extinguishing system when installation is complete. Perform system testing only after hazard-area enclosure construction has been completed and openings sealed. Comply with operating instructions and procedures of NFPA 2001, Section "Approval of Installations." Include the following to demonstrate compliance with requirements:

- Perform functional predischarge test.
- Perform system functional operational test.
- Check remote monitoring operations.
- Check control-panel primary power source.
- Perform "puff" test on piping system, using nitrogen.

- Correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment that cannot be corrected or does not perform as specified and indicated, then retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.

320.080 CLEANING

- Each pipe section shall be cleaned internally after preparation and before assembly by means of swabbing, using a suitable nonflammable cleaner. Pipe network shall be free of particulate matter and oil residue before installing nozzles or discharge devices.

320.090 OPERATIONAL CONDITION SYSTEM FILLING

- Preparation:

  - Verify that clean-agent fire-extinguishing system and protected enclosure have passed all required tests and inspections in accordance with NFPA 2001.
  - Verify that clean-agent fire-extinguishing piping system installation is completed and cleaned.
  - Verify complete enclosure integrity.
  - Verify operation of ventilation and exhaust systems.

- Filling Procedures:

  - Fill clean-agent fire-extinguishing containers with extinguishing agent, and pressurize to indicated charging pressure.
  - Install filled containers.
  - Energize circuits.
  - Adjust operating controls.

320.100 DEMONSTRATION

- Engage a factory-authorized service representative to train Employer's maintenance personnel to adjust, operate, and maintain clean-agent fire-extinguishing systems.

S71 FOAM FIRE FIGHTING

PART 3 SPECIFICATION CLAUSES SPECIFIC TO S71

300.000 GENERAL

300.010 SYSTEM DESCRIPTION

- Description: Engineered, fixed, wet-pipe deluge, automatically actuated, low-expansion, AFFF fire-extinguishing system for flammable-liquid fires. System includes diaphragm proportioning tanks and devices as described in NFPA 11.

300.020 SUBMITTALS

- Delegated-Design Submittal: For foam-water systems indicated to comply with performance and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

300.030 MAINTENANCE MATERIAL SUBMITTALS

- Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Owner.
    - Discharge Devices: Not less than 20 percent of amount of each type installed.
    - Foam Concentrate: Not less than 200 percent of amount installed.

300.040 QUALITY ASSURANCE

- Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of kind indicated. Engineering services are defined as those performed for installations of low-expansion, AFFF fire-extinguishing systems that are similar to those indicated for this Project in material, design, and extent.

- Source Limitations: Obtain foam concentrate, proportioning tanks, and major accessories through one source.

- Product Options: Drawings indicate size, profiles, and dimensional requirements of foam fire-extinguishing systems and are based on the specific system selected. Other manufacturers' foam fire-extinguishing systems complying with requirements may be considered. Refer to Division 1 Section "Product Requirements."

- Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators in accordance with ASME Boiler and Pressure Vessel Code.

310.000 PRODUCTS/MATERIALS

310.010 PERFORMANCE REQUIREMENTS

- Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

- NFPA Compliance: Fabricate and label AFFF fire-extinguishing systems to comply with NFPA 11and NFPA 11.

- ASME Compliance: Fabricate piping to comply with ASME B31.1.

- FM Global Compliance: Provide components that are FM Approved and that are listed in FM Approvals' "Approval Guide."

- UL Compliance: Provide foam concentrate and equipment complying with UL 162, "Foam Equipment and Liquid Concentrates," and equipment listed in UL's "Fire Protection Equipment Directory."

- Standard Working Pressure of Piping-System Component: Listed for a minimum of 1200 kPa (175 psig).

- Unless authorities having jurisdiction have stricter requirements, minimum design parameters are as follows:

    - Solution: 3 percent foam-water solution.
    - Sprinkler Spacing: Maximum of 9.5 sq. m (100 sq. ft.) per sprinkler, and maximum 3.7-m (12-foot) spacing.
    - Design Density: Minimum 0.108 L/s per sq. m (0.16 gpm/sq. ft.).
    - Foam Supply: Minimum 10-minute discharge time.
    - Water Supply: Minimum 60 minutes.
    - Remote Area: Minimum 476-sq. m (5000-sq. ft.) design area for closed-sprinkler systems. Open-sprinkler systems shall discharge over the entire system area.
    - Sprinkler Temperature Rating: Maximum 121 to 149 deg C (250 to 300 deg F) at a roof or ceiling, and 57 to 77 deg C (135 to 170 deg F) for intermediate sprinklers.

- Seismic Performance: Fire-suppression piping shall withstand the effects of earthquake motions determined in accordance with NFPA 13.

    - The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
    - Component Importance Factor: 1.5.

310.020 CONCENTRATE PIPING MATERIALS

- Comply with requirements specified in Section S63 for pipes, fittings, joining materials, and valves.

- Schedule 40, Black Steel Pipe: ASTM A53/A53M, Type E or Type S, Grade B or ASTM A795/A795M, Type E or Type S. Pipe ends may be factory or field formed to match joining method.

    - Gray Iron Threaded Fittings, Classes 125 and 250: ASME B16.4.
    - Gray Iron Pipe Flanges and Flanged Fittings: ASME B16.1.
    - Malleable Iron Threaded Fittings, Classes 150 and 300: ASME B16.3.

310.030 FOAM SOLUTION PIPING MATERIALS

- Comply with requirements specified in Section S63 for pipes, fittings, joining materials, and valves.

- Schedule 40, Black Steel Pipe: ASTM A53/A53M, Type E or Type S, Grade B or ASTM A795/A795M, Type E or Type S. Pipe ends may be factory or field formed to match joining method.

    - Gray Iron Threaded Fittings, Classes 125 and 250: ASME B16.4.
    - Gray Iron Pipe Flanges and Flanged Fittings: ASME B16.1.
    - Malleable Iron Threaded Fittings, Classes 150 and 300: ASME B16.3.

- Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E or Type S; Grade B, Schedule 40.

    - Gray Iron Threaded Galvanized Fittings, Classes 125 and 250: ASME B16.4.
    - Malleable Iron Galvanized Threaded Fittings, Classes 150 and 300: ASME B16.3.

310.040 VALVES

- Comply with requirements specified in Section S63

    - UL listed or FM Approved for use in fire-protection systems.
    - Compatible with type of foam concentrate used.

310.050 SYSTEM COMPONENTS

- Source Limitations: Obtain system components from single source from single manufacturer.

- System components to be in accordance with NFPA 11, be compatible with the foam concentrate, and be designed to be drained and cleaned.

- Foam-Concentrate Storage Tanks:

    - Buna-N, bladder-type proportioning tank complying with UL 162 and ASME Boiler and Pressure Vessel Code: Section VIII; designed for use with foam-concentrate pumps and for specific type of foam concentrate used. Include bladder, internal piping, fill and drain, glass sight gage, piping, and valves. Contain concentrate in the bladder.

        - Orientation: Vertical design with skirt support.

- Foam-Concentrate Pumps: Listed for use in foam-water systems in accordance with NFPA 20. Include supply-side pressure relief valve and drain cock or valve.

- Proportioning Controllers: Venturi type complying with UL 162 and of capacity to match design at minimum and maximum flow.

- Concentrate Control Valves: Water-operated ball or deluge valve designed to open with flow through the proportioning controller.

- Concentrate Strainers: Bronze body and stainless steel mesh strainer with minimum 3.2-mm (0.125-inch) perforations to remove solids that would block system components.

- Pressure Gauges: Comply with UL 393; with 90-mm (3-1/2-inch) minimum-diameter dial, 0- to 2070-kPa (0- to 300-psig) dial range, and caption "WATER" or "CONCENTRATE" on dial face.

310.060 FOAM CONCENTRATE

- Description: AFFF liquid concentrate, complying with NFPA 11 and UL 162, for making foam-water fire-extinguishing foam solution.

310.070 DISCHARGE DEVICES

- Discharge devices shall be UL listed or FM Approved.
- Sprinklers: Openair-aspirating type; UL listed or FM Approved and listed for use with type of foam concentrate used.
- Spray Nozzles: For foam water; include foam generator and distributing deflector to distribute foam or water.

310.080 MONITORING DEVICES

- Valve Supervisory Switches: Single pole, double throw, with normally closed contacts complying with UL 753. Switch shall signal an alarm condition at fire-alarm panel or releasing panel when valve is in other than fully open position.
- Pressure Switches: Single pole, double throw, UL listed or FM Approved and complying with UL 753. Switch shall signal an alarm condition at fire-alarm panel or releasing panel when switch is in other than fully open position.
- Flow Switches: Single pole, double throw, UL listed or FM Approved and complying with UL 753. Switch shall signal an alarm condition at fire-alarm panel or releasing panel when switch is in other than fully open position.
- Comply with NFPA 11 and NFPA 72.

310.090 ALARM DEVICES

- Description: UL listed or FM Approved, low voltage, and surface mounting, unless otherwise indicated.

320.000 WORKMANSHIP

320.010 CONCENTRATE STORAGE TANK INSTALLATION

- Equipment Mounting:
    - Install concentrate storage tanks on cast-in-place concrete equipment bases.
- Install concentrate storage tanks anchored to substrate in accordance with tank manufacturer's written instructions.
- Install tanks level and plumb, in accordance with layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
- Install seismic restraints for tanks. Anchor tanks to substrate.

320.020 PIPING INSTALLATION

- Install piping and components level and plumb.

- Install pipe and fittings, valves, and discharge devices in accordance with requirements listed in NFPA 11, "Installation of Foam-Water Sprinkler and Foam-Water Spray Systems."

    - Support piping using supports and methods in accordance with NFPA 13.
    - Install seismic restraints for concentrate storage tanks and piping systems.
    - Install monitoring and alarm devices in accordance with NFPA 11 and NFPA 72.

- Install flanges, flange adapters, or couplings for grooved-end piping on piping, valves, apparatus, and equipment having DN 65 (NPS 2-1/2) and larger end connections.

- Ream ends of pipes and tubes and remove burrs.

- Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.

- Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for foam concentrate. Join flanges with gasket and bolts in accordance with ASME B31.9.

- Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

    - Apply appropriate tape or thread compound to external pipe threads.
    - Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

- Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe in accordance with AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings in accordance with AWWA C606 for steel-pipe joints.

- Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe in accordance with AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings in accordance with AWWA C606 for steel-pipe grooved joints.

- Welded Joints: Construct joints in accordance with AWS D10.12M/D10.12, using qualified processes and welding operators in accordance with "Quality Assurance" Article.

    - Shop weld pipe joints where welded piping is indicated.

- Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems and with foam concentrate.

320.030 PIPING CONNECTIONS

- Comply with requirements for piping specified in Section S63 Drawings indicate general arrangement of piping, fittings, and specialties.

- Provide concentrate control and drain valves with piping to permit maintenance of foam concentrate with continuous sprinkler-system service.

- Install proportioning controller in fire-suppression piping to provide coverage to area indicated on Drawings.

- Where installing piping adjacent to equipment, allow space for service and maintenance.

320.040 ELECTRICAL CONNECTIONS

- Connect electrical devices to building's fire alarm system.
- Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
- Install a fire-department connection on the supply side of the proportioning controller when required.

320.050 LABELING

- Install labeling on piping, equipment, and panels in accordance with NFPA 11, and Section Z254.

320.060 CHARGING SYSTEM

- Fill proportioning tanks with foam concentrate after field quality-control testing is complete and satisfactory results have been achieved.

320.070 FIELD QUALITY CONTROL

- Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- Tests and Inspections: Comply with operating instructions and procedures in NFPA 11, Chapter "Acceptance Tests." Include the following tests and inspections to demonstrate compliance with requirements:
    - Engage the services of a qualified professional engineer to inspect installed fire-extinguishing systems, prepare installation report, and certify that installation complies with the Contract Documents, calculations, and requirements of authorities having jurisdiction.
    - Check mechanical items.
    - Inspect equipment and check mountings for adequate anchoring to substrate.
    - Check electrical systems.
    - Flush supply piping.
    - Perform hydrostatic pressure test.
    - Perform acceptance test.
    - Perform proportioning system test.
    - Perform discharge test.
    - Flush system piping.
    - Correct malfunctioning equipment; retest to demonstrate compliance. Replace equipment that cannot be satisfactorily corrected or does not perform as specified and indicated; retest to demonstrate compliance. Repeat procedure until satisfactory results are obtained.
    - After installing foam-water fire-extinguishing piping system and after electrical circuitry has been energized, test for compliance with NFPA 11.
    - Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
    - Operational Test: After electrical circuitry has been energized, start systems to confirm proper unit operation.
    - Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

- Foam fire-extinguishing piping system will be considered defective if it does not pass tests and inspections.

- Prepare test and inspection reports.

320.080 DEMONSTRATION

- Demonstrate equipment, specialties and accessories, and train Employer's maintenance personnel to adjust, operate, and maintain fire-extinguishing foam piping and equipment.

T60 - CENTRAL REFRIGERATION PLANT

PART 3 SPECIFICATION CLAUSES SPECIFIC TO T60

300.000 GENERAL:

300.001 PRESSURE EQUIPMENT DIRECTIVE/PRESSURE EQUIPMENT REGULATIONS:

- All equipment and assemblies which fall within the scope of the Pressure Equipment Directive (PED) 2014/68/EU, must be tested by the manufacturers and be certified as compliant with the Directive. Such compliance shall be evidenced by displaying the appropriate CE Mark on the equipment and assemblies.
- Only relevant equipment and assemblies certified as compliant will be permitted under this specification, and any substitution put forward must also be compliant with the Directive.

300.030 WORKS INSPECTION AND TESTING:

- Include for inspection at manufacturer's works.
- Plant shall be witness tested in the presence of the client's representative and a certified test report shall be provided. Allow for cost of the test and the cost for travel and accommodation, as necessary, to take the project team to the test facility
- Thermal performance/capacity testing
    - Conduct capacity test in a purpose built test chamber with all facilities, instruments and equipment in order to operate and record the chiller performance at the specified conditions. The test facility shall be independently certified and quality assured to BS EN ISO 9001. Provide copies of all calibration certificates used in testing. Provide a method statement for the test work 2 weeks prior to test including how the specified design ambient temperature will be achieved and maintained during the test.
    - Operating conditions to be recorded during testing
- Acoustic testing
    - Measure maximum sound pressure level measurements around all sides of the plant, not the average level.
    - Establish any tonal character from the chiller. This is defined as, "no 1/3 octave band sound pressure level measured at 1m shall differ from it's two adjacent 1/3 octaves by more than 5dB".
    - Low noise air cooled chillers shall be used; Contractor to conduct an acoustical study to ensure selected chiller does not cause noise level to rise above the expected noise during normal operation or as requested by Authorities whichever is more stringent.

300.035 SITE PERFORMANCE TESTING AND COMMISSIONING:

- Chillers
    - Field Quality Control
        - Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and chiller installation, including piping and electrical connections. Report results in writing.
            - Test and adjust controls and safeties.
            - Replace damaged or defective and malfunctioning components, controls and equipment.

- Correct deficiencies identified by observations and tests; retest until specified requirements and satisfactory results are obtained.

- Cleaning
  - After completing installation, including outlet fittings and devices, inspect unit components.
  - Remove paint splatters and other spots, dirt, and debris.
  - Repair damaged finish to match original finish.
- Commissioning
  - Verify that installation complies with Contract requirements.
  - Complete installation and startup checks according to manufacturer's written instructions and check for the following items:
    - No physical damage to unit.
    - Unit is level.
    - Chiller vibration isolation and flexible pipe connections are installed.
    - Clearances have been maintained and piping is installed for easy removal for service and tube cleaning.
    - Chilled water pipes have been connected to correct ports.
    - Labels and safety instructions are clearly visible.
    - Oil levels are as recommended by the manufacturer.
    - Refrigerant charge is sufficient and chiller has been leak tested.
    - Shipping skids, blocks, and straps are removed.
    - Refrigerant pressure relief is vented to outside.
    - Thermometers and pressure gages are installed.
    - Controls and safety interlocks are installed and connected.
    - Pumps are installed, connected, and operational.
  - Start-up: Chiller manufacture to provide a factory-trained representative to perform the following services:
    - Leak testing.
    - Refrigerant pressure testing.
    - Evacuation.
    - Dehydration.
    - Charging the chiller with refrigerant.
    - Check and record performance of chiller protection devices.
    - Check and record performance of chilled- and condenser-water flow and low-temperature interlocks.
    - Operate chiller for run-in period as recommended by the manufacturer.
    - Check static deflection of vibration isolators, including deflection during chiller startup and shutdown.
    - Check refrigerant charge.
    - Check oil level.
  - After the above services have been performed, the same factory-trained representative shall be available for fifteen days to instruct the owner's personnel in the proper operation and maintenance of the chiller.
  - The Contractor shall supply the owner with the following literature as furnished by the manufacturer prior to start-up:

- One complete set of installation drawings
- Wiring diagrams
- Installation instructions
- Start-up instructions
- Operation and maintenance instructions.

- Guarantee the main electric motor starters shall be furnished and guaranteed by the chiller manufacturer who will be responsible for the refrigeration system performance and its control.

- Final Assembly, testing and start-up

  - Manufacturer shall be responsible for supervising the installation of the ship loose components of the chiller on-site.
  - Manufacturer is responsible for the reconnection of all control wiring from the chiller to the chiller control panel and starter.
  - Manufacturer shall perform the onsite pre-commissioning, commissioning and startup of the new chiller.

    - These activities include the 48 hour pressure test of refrigerant side components at factory specified test pressures, dehydration, and evacuation of refrigerant side components.
    - Manufacturer must provide two evacuations & dehydration tests, to be signed off by the Owner/Engineer, before charging of system.
    - The pressure level achieved by each evacuation shall not exceed 100 milli-bar absolute.
    - Charging of refrigerant and oil to be performed by manufacturer.

  - Manufacturer shall reconfirm the proper operation of the chillers control system in all modes of operation, including all shutdowns.

- Acoustic testing

  - Measure maximum sound pressure level measurements around all sides of the plant, not the average level.

- Seasonal performance test: During the Defects Liability Period, when instructed by the Engineer, engage a factory-authorized service representative to conduct a seasonal performance test according to requirements of the Engineer. Report results in writing.

300.050 MAINTENANCE:

- Provide full installation and commissioning instructions including:

  - Normal operation and emergency procedures.
  - Fault analysis guide.
  - Manufacturer's test and commissioning certificates.
  - Recommended maintenance instructions.
  - Daily, weekly, monthly, 6 monthly and annual maintenance schedules.
  - List of recommended spares, including cost and anticipated operational life.

- Ensure that major components are readily accessible for maintenance without dismantling or removing other components.

300.060 SAFETY STANDARDS AND REGULATIONS:

- Comply with BS EN ISO 12100, BS EN 378 and BS EN 12693.
- Comply with F-Gas Regulations.

- Comply with HSC ACOP L8 and associated technical guidance HSG274 Part 1 as appropriate.
- Provide sample points in the cooling system pipework to enable sampling to be undertaken in accordance with local authority regulations
- Pipe discharges from safety valves to be located at a safe point away from any fresh air intakes or openable windows (external to the building for plant in enclosed plant rooms). The discharge point shall be such that persons and property are not endangered by a release of the refrigerant and be well away from any fresh air intakes or openable windows.

300.070 EQUIPMENT:

- Equipment to be certified with CE mark in accordance with The Energy Related Products Regulations 2010 as amended.
- Ecodesign requirements
    - Cooling Only Chillers
        - Chillers to comply with EU Regulation 2016/2281 with regard to ecodesign requirements, including seasonal space cooling (or heating), energy efficiency (SSCEE / SSHE) and product information.
- Fans incorporated into plant with electric input between 125W and 500kW to comply with EC Regulation 327/2011 with regard to ecodesign requirements.
- The full load Energy Efficiency Ratio (EER) of plant shall be in accordance with BS EN 14511.
- The Seasonal Space Cooling Energy Efficiency (SSCEE) of plant shall be in accordance with BS EN 14825.
- Provide interface to BMS. Comply with requirements of section W60
- Comply with the following standards:
    - Refrigerating compressors
        - Performance testing in accordance with BS EN 13771-1 and BS EN 12900
        - Use lubricating oils in accordance with BS ISO 6743-3 and manufacturer's recommendations.
        - Safety of motor-compressors to BS EN 60335-2-34
    - Refrigerating condensers
        - Performance testing in accordance with BS EN 13771-2 and BS EN 13215
    - Motors
        - BS EN 60034-30-1 and BS EN 50347 as applicable to 3-phase cage-induction motors.
        - Starter
            - Type - Soft starter
            - Comply with section Y92A for specifications of starters and VSD
            - For motors less than 50 HP, may be proposed by the manufacturer subject to compliance with Y92A and Engineer approval.
    - Pressure vessels to relevant parts of BS EN 13445 and BS EN 14276-1 for general requirements for material, design, manufacturing, testing and documentation.

300.076 REFRIGERANTS:

- CFC and HCFC refrigerants are prohibited and must not be used.

- Provide each chiller with automatic shutdown and pump down of refrigerant on the detection of refrigerant leakage/charge loss. Provide automatic isolation valves to contain the refrigerant once fully pumped down.
- The Contractor shall provide the complete charge of refrigerant in accordance with manufacturer's recommendations. Any refrigerant that has been lost from the system shall be replaced.
- All refrigerants must have global warming potential (GWP) of less than 10 or Direct Effect Life Cycle CO_2 equivalent emissions of 100kgCO_{2e}/kW cooling capacity.
- All refrigerants must have Direct Effect Life Cycle CO_2 equivalent emissions of 1000kgCO_{2e}/kW cooling capacity.

310.000 PRODUCTS/MATERIALS:

310.020 PACKAGED AIR COOLED LIQUID CHILLER - SCREW COMPRESSOR:

- Type
  - Cooling Only
    - Supply air cooled packaged liquid chiller complete with motors, semi-hermetic twin screw compressors, condenser, evaporator, heat rejection fans, starting and control equipment, and all auxiliary and ancillary items, to complete refrigeration cycle.
- Capacity, testing, unit rating and functional testing
  - To be in accordance with conditions, requirements, methodologies, definitions, calculations and measurement approaches to be set out in the standards below. Unit efficiency ratings to account for the fraction of internal or external pump power to overcome internal static pressure difference:
    - BS EN 14511-1 - Terms and definitions
    - BS EN 14511-2 - Test conditions
    - BS EN 14511-3 - Test methods
    - BS EN 14511-4 - Operating requirements
    - BS EN 14825 for testing and rating at part load conditions and calculation of seasonal performance.
- Duty
  - Minimum Seasonal Space Cooling Energy Efficiency (SSCEE)
    - Minimum value in accordance with EU Eco-Design Requirements]
  - Refrigerant
    - R134a
    - Normal operating pressure (2070 kPa)
  - Chilled water
    - Normal operating pressure (1035 kPa)
  - Evaporator
    - Type
      - Shell and tube type

- Shell – Carbon-steel plate
- Tubes - Seamless copper; expanded into tube sheets; individually replaceable; externally finned; with standard, removable, carbon-steel, marine type, water boxes.
- Internal Finish - Internally ribbed or smooth tubes

- Class O/UV stable insulation.
- Evaporator fouling factor 0.0001

- Condenser
  - Micro channel aluminium.
  - Casing
    - Weatherproof, constructed of hot-dip galvanized steel with factory-painted finish
  - Condenser fans
    - Propeller type, statically and dynamically balanced.
    - Fan Motor
      - Electronically Commutated/DC motor
      - Direct drive, weatherproof, with bearings permanently lubricated, and having built-in current- and thermal-overload protection.
    - Provide modulating head pressure control to control fan speed to maintain constant condensing pressure.
- Capacity control
  - Speed changing by frequency inverter.
- Safety devices
  - Comply with BS EN 378, BS EN 12693 and provide protection against high pressure.
  - 3-way dual shut-off valve assembly incorporating 2 relief valves per circuit to allow maintenance of individual pressure relief valves without the need for refrigerant evacuation.
  - Reverse rotation on normal or emergency stops.
  - Failure of lubricating system (auto-stop).
  - Low chilled water flow.
  - Low chilled water temperature.
  - High oil temperature.
  - Low oil temperature.
  - Over or under voltage.
  - Phase reversal.
  - Frequent starting.
  - Power interruption.
- Ancillaries
  - Differential oil pressure switch.
  - Oil heater.
  - Filter drier with isolating valves.
  - Oil filter/strainer with isolating valves.
  - Evaporator differential pressure sensor to monitor pressure drop and raise alarm.
- Accessories
  - Economiser comprising dedicated EEV and plate heat exchanger.
  - Oil pressure gauge.

- Oil level sight glass to BS EN 12178
- Refrigerant suction and discharge stop valves.
- Flow switch supplied loose for site mounting in chilled water pipework.
- Acoustically lined compressor enclosure.
- Condenser fan discharge air plenum extension
    - Construct from galvanised sheet steel coated with epoxy baked powder paint. Plenum to direct discharge air vertically to limit air re-circulation and provide a degree of acoustic reduction in the horizontal plane.
- Anti-vibration mountings
    - **Pad type supplied loose for site fitting.**
- Fixed, automatic leak detection system fitted within the compressor enclosure
- Automatic shutdown and pump down of refrigerant on the detection of the refrigerant leakage/charge loss. Provide automatic isolation valves to contain the refrigerant once fully pumped down.
- Remote chilled water set point adjust facility to enable chilled water temperature to be adjusted via a 0-10V signal.
- Sequence control facility for multiple chiller installation with common chiller inlet and outlet temperature sensors (in addition to each chillers' outlet temperature control and protection sensor). System to provide capacity control sensor selection, allow control in all possible sequence permutations, optimise chiller and compressor run and load sequence by varying control parameters to maintain common fluid outlet temperature and facility to carry out automatic compressor and chiller lead/lag selection to balance compressor and chiller run hours.
- Heat recovery facilities including all necessary controls and fittings for hot water production
- Marking, technical data sheets and instructions

- Mark units and provide technical data sheets and instructions for control, installation and maintenance in accordance with BS EN 14511-4 - Operating requirements

320.000 WORKMANSHIP:

320.010 GENERAL:

- Install equipment in accordance with equipment manufacturer's requirements.
- Comply with statutory and Local Authority requirements and by-laws.

320.020 CONNECTIONS:

- Observe manufacturer's requirements and instructions.

320.030 ACCESS:

- Ensure plant is located to allow access for operation and maintenance as required by manufacturer.

320.040 CLEANSING:

- Observe manufacturer's requirements and instructions. Provide valved flushing connections adjacent to plant.

320.050 EXPANSION TANK INSTALLATION:

- Install expansion vessels and ancillary equipment for systems including safety valve for chilled water and condenser systems in accordance with BS 7074-3.

T62 - VRF SYSTEM

PART 3 SPECIFICATION CLAUSES SPECIFIC TO T62

300.000 PLANT AND EQUIPMENT

300.001 PRESSURE EQUIPMENT DIRECTIVE/PRESSURE EQUIPMENT REGULATIONS:

- All equipment and assemblies which fall within the scope of the Pressure Equipment Directive (PED) 2014/68/EU must be tested by the manufacturers, and be certified as compliant with the Directive. Such compliance shall be evidenced by displaying the appropriate CE Mark on the equipment and assemblies.
- Only relevant equipment and assemblies certified as compliant will be permitted under this specification, and any substitution put forward must also be compliant with the Directive.

300.015 SAFETY AND ENVIRONMENTAL REQUIREMENTS:

- Comply with the relevant parts of BS EN 378 in the design, construction, testing, marking and documentation of the equipment and the system installation

300.016 ECODESIGN / EER REQUIREMENTS FOR AIR CONDITIONERS:

- Equipment to be certified with CE mark in accordance with The Energy Related Products Regulations 2010 as amended.
- Fans incorporated into plant with electric input between 125W and 500kW to comply with EC Regulation 327/2011.
- Ecodesign Requirements
    - Heating or Cooling/Heating Units
        - Units with a rated capacity of up to 12kW to comply with EU Regulation 206/2012.
        - Other units with a rated heat output up to 400kW to comply with EU Regulation 813/2013 with regard to ecodesign requirements.
        - Units greater than 400kW to comply with EU Regulation 2016/2281 with regard to ecodesign requirements, including seasonal space cooling (or heating), energy efficiency (SSCE / SSHE) and product information / instruction manuals information on disassembly, recycling and/or disposal.
- The full load Energy Efficiency Ratio (EER) of plant shall be in accordance with BS EN 14511.

300.020 INDOOR UNITS:

- **Type**
    - Provide indoor units capable of cooling or heating the space and suitable for connection to a single external unit and operating under the variable refrigeration volume system. All units connected to a single external unit would cool or heat in unison.
- Mounting
    - Ceiling mounted cassette double flow.
    - Ceiling mounted cassette multi flow.
    - Concealed horizontal.
    - Concealed vertical.

    - Cased horizontal.
    - Cased vertical low level.
    - Cased vertical high level (down flow).
- Duty
    - Refrigerant
        - R410A
        - R407C
        - R32
- Standard
    - BS EN 14511-1
    - BS EN 14511-2
    - BS EN 14511-3
    - BS EN 14511-4
    - BS EN 60335-2-40 and BS EN 60335-1 - safety requirements
- Casing
    - Galvanized steel
    - Removable panels for service
- Finish
    - Manufacturer's standard.
- Refrigerant Coil
    - Direct expansion coil with capillary restrictor
    - Seamless copper tubes mechanically expanded into aluminum fins
- Access - Provide access to filter, fan and motor.
- Roomside fan
    - Centrifugal with direct coupled motor.
- Filter
    - Washable.
- Grille type
    - Adjustable.
- Insulation - Provide thermal and acoustic insulation.
- Controls
    - Display
        - Operating.
        - Program dry function.
        - Defrost/hot start.
        - Filter dirty.
        - Temperature setting.
        - Timer.
        - Air flow.
        - Fault.
    - Auxiliary contacts to wire to external source

        - Normally open contacts.
        - Momentary open contactor.
        - Alarm/fault.
        - Temperature setting.
        - Start/stop.
        - Temperature monitoring.
        - Monitor all unit functions.
    - Condensate drainage
        - Natural.
    - Controls
        - Function
            - Start/stop.
            - Temperature setting.
            - Timer settings (units of 1 hr to 72 hr).
            - Air flow setting.
            - Air flow direction adjustment.
        - Control panel with motor starters by same VRF manufacturer
        - Availability of interface with BMS system. Comply with requirements of section W60.

300.050 DISTRIBUTOR CONTROLLERS:

- Provide distribution controllers to link between external unit and internal units
- Provide spare connections for future units

300.060 EXTERNAL UNIT:

- Provide external unit with minimum of 2 scroll compressors, coil and fan. Provide compressor complete with heater, suction and delivery valves, service connection and high and low safety switches. Incorporate receiver. All compressors shall be inverter driven.
- Fan
    - Propeller type
    - Material – Plastic
    - Motor
        - Direct drive
        - DC inverter type motor
- Coil
    - Multi-pass, cross-finned tube type
    - Tubes - Copper
    - Fins
        - Aluminum
        - Covered by anti-corrosion resin film
- Casing
    - Provide weatherproof casing constructed from
        - Galvanised sheet steel.

- Finish
    - Baked enamel
- Internal pipework
    - Seamless, round copper tube to BS EN 12449.
    - Seamless, round copper capillary tube to BS EN 12450
- Internal pipework insulation
    - Manufacturer's standard.
- Control
    - Control panel with motor starters by same VRF manufacturer
    - Availability of interface with BMS system. Comply with requirements of section W60.

300.070 VIBRATION ISOLATION:

- Provide vibration isolation to manufacturer's standard vibration isolation.
- Include heavy base for unit support.

300.080 REFRIGERANT PIPING SYSTEM:

- Pipe Material
    - Seamless copper tube to BS EN 12735-1
        - Material condition (or temper)
            - Soft (R220) coiled.
            - Half hard (R250) straight lengths.
            - Hard (R290) straight lengths.
        - To be selected by the equipment manufacturer or the specialist pipework installer to suit the application, maximum operating temperature and pressure and refrigerant.
- Comply with the requirements of the BS EN 14276-2 and relevant parts of BS EN 378
- Jointing
    - High temperature 'silver' solder
- Support
    - Support all pipework and controls cabling throughout their length using cable tray, firmly fixed to the building fabric.
    - Perforated cable tray
        - Flanged.
        - Return.
    - Perforations and thickness - Manufacturer's standard.
- Fittings
    - Use factory made fittings throughout of same material type, pattern, finish and thickness as tray.

300.100 PIPEWORK INSULATION

- Insulate entire length of pipework for thermal insulation and to avoid contact between copper and galvanising of support tray.
- Closed cell nitrile rubber preformed flexible sections
    - CFC free.
    - Fire rating (class): B-S2-d0
    - Install un-split wherever possible.
    - Use manufacturer's standard glue for jointing.
    - Ensure vapour barrier is maintained on
        - All pipework.
- Protection
    - Paint
        - Manufacturer's standard colour.
    - Wrap fittings and valves with same insulation as pipework.
    - Provide aluminium valve boxes.
- Insulation thickness (mm): 25

300.105 SPARE PARTS FOR INDOOR UNITS:

- Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
    - **[Filters: Furnish [1] spare filter[s] for each filter installed.]**
    - **[Fan Belts: Furnish [1] spare fan belt[s] for each unit installed.]**

310.000 PLANT AND EQUIPMENT WORKMANSHIP

310.010 PLANT AND EQUIPMENT INSTALLATION:

- Install equipment in accordance with manufacturer's recommendations.

U12 - KITCHEN VENTILATION

PART 3 SPECIFICATION CLAUSES SPECIFIC TO U12

300.000 GENERAL

300.001 PRESSURE EQUIPMENT DIRECTIVE/PRESSURE EQUIPMENT REGULATIONS:

- All equipment and assemblies which fall within the scope of the Pressure Equipment Directive (PED) 2014/68/EU must be tested by the manufacturers, and be certified as compliant with the Directive. Such compliance shall be evidenced by displaying the appropriate CE Mark on the equipment and assemblies.
- Only relevant equipment and assemblies certified as compliant will be permitted under this specification, and any substitution put forward must also be compliant with the Directive.

300.010 SPECIALIST:

- Use a specialist to manufacture, supply and install kitchen canopy equipment.

310.000 PRODUCTS/MATERIALS

310.010 KITCHEN CANOPIES:

- Electricity safety to BS EN 60335-2-99.
- Supply kitchen canopies in accordance with DW/172.
- Types of canopy - DW/172.
    - Overhead wall type canopy
        - Wall-mounted.
        - Island mounted.
    - Integral make-up air facility
        - Front face perforated diffuser.
        - Internal slot - induction, entrainment capture, compensating or short circuit.
    - Materials
        - Stainless steel.
            - Finish
                - As chosen by Engineer.
    - Construction
        - In accordance with DW/172.
    - Grease filtration - DW/172.
        - Mesh or impingement filters. (Secondary filtration)
        - Baffle filters.
        - Water wash.
    - Internal lighting - DW/172.

- Fire suppression – to NFPA 17A.
    - Description: Engineered distribution piping designed for automatic detection and release or manual release of fire-suppression agent by hood operator. Fire-suppression system shall be listed and labeled for complying with NFPA 17A, "Wet Chemical Extinguishing Systems," by a qualified testing agency acceptable to authorities having jurisdiction.
        - Steel Pipe, NPS 2 (DN 50) and Smaller: ASTM A 53/A 53M, Type S, Grade A, Schedule 40, plain ends.
        - Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300.
        - Piping, fusible links and release mechanism, tank containing the suppression agent, and controls shall be factory installed. Controls shall be in stainless-steel control cabinet mounted on hood or wall. Furnish manual pull station for wall mounting. Exposed piping shall be covered with chrome-plated aluminum tubing. Exposed fittings shall be chrome plated.
        - Liquid Extinguishing Agent: Noncorrosive, low-pH liquid.
        - Furnish electric-operated gas shutoff valve with clearly marked open and closed indicator for field installation.
        - Fire-suppression system controls shall be integrated with controls for fans, lights, and fuel supply and located in a single cabinet for each group of hoods immediately adjacent.
        - Wiring shall have color-coded, numbered terminal blocks and grounding bar. Spare terminals for fire alarm, optional wiring to start fan with fire alarm, red pilot light to indicate fan operation, and control switches shall all be factory wired in control cabinet with relays or starters. Include spare terminals for fire alarm, and wiring to start fan with fire alarm.

310.020 GREASE FILTERS:

- Filter Media
    - Corrugated aluminium sheet with expanded aluminium protective face.
- Filter frame
    - Stainless steel.
- Filter Housing
    - Incorporate method of retaining media cell and collecting tray within housing.
    - Material
        - Stainless steel.
    - Access
        - Top.
- Cleaning Tank
    - Provide sheet metal cleaning tank with detergent cleaning compartment with drainage grids and dipping compartment.
- Cleaning materials
    - Provide bottles of cleaning detergent.

310.021 KITCHEN VENTILATION GAS SAFETY INTERLOCK FACILITIES:

- Standards
  - Provide an interlock between all kitchen gas appliances and supply and extract ventilation to kitchens, such that the ventilation system operation must be proved before the gas appliance can be used, in accordance with BS 6173.
  - Comply with IGEM/UP/19 for the design and application of interlock devices and associated systems used with gas appliance installations in commercial catering establishments.
- Scope
  - Control panel, pressure switch or sensing device, gas isolation control valve and all interconnecting power and control wiring.
- Supply and install interlock system in accordance with the manufacturer's recommendations.
- Required interlocks
  - Primary interlock between ventilation system and appliances using differential pressure switch to shut gas isolation valve and lock out appliance on low pressure failure.
  - Primary interlock between ventilation system and appliances by monitoring power used by fans to shut automatic gas isolation valve and lock out appliance on low absorbed power.
  - Secondary interlock to shut gas isolation valve and lock out appliance on sensing high CO_2.
  - Secondary interlock to shut gas isolation valve and lock out appliances on fan failure or trip.
  - Interlock with fire detection system
  - Interlock with gas detection system
- BMS interface requirements as shown on Drawings.
- Where appliances do not have flame failure devices provide a pipework integrity system (formerly referred to as weep by-pass system) in accordance with Appendix 12 in IGEM/UP/2 Edition 3.

310.022 KITCHEN ECOLOGY UNIT:

- Supply ecology unit complete with casing and filtration elements from a single manufacturer
- Casing – Reference Z240.020
- Fan and motor
  - Single inlet single width, airfoil centrifugal fan statically and dynamically balanced
  - Comply with general clauses under Z240.030
- Filters
  - Pre-Filter
    - 2” thick
    - Stainless steel
    - Class to BS EN ISO 16890-1
    - Washable type
    - With drain tray for grease collection
  - Electrostatic Precipitator
    - Suitable for kitchen smoke control
    - To have charging section and collection section

        - With drip tray and oil drain point
        - Minimum efficiency 95%
    - Bag Filter
        - 15” thick
        - Compact rigid box type
        - Glass fibre media
        - Mini pleated construction
        - Class to BS EN ISO 16890-1
            - ISO ePM10 90-95% efficiency
    - HEPA Filter
        - 12” thick
        - Compact rigid box
        - Galvanized metallic cell sides
        - Glass fibre media
        - Mini pleated construction
        - Class to BS EN 1822
            - H14
- Odor control module
    - Pellets
        - Metal cells filled with activated alumna pellets impregnated with potassium permanganate
        - Odor media to be non-toxic and non-flammable
        - Pellets to be contained in perforated cells located in a separate odour reduction section normally located between the filter box and the tan box
        - All of the exhaust air is drawn over the pellets whenever the fan is operating.
        - The cells are removed through a side access door on the odor section.
    - UV-module
        - Self-cleaning inner surface.
        - High output lamps designed to run for 13,000 hrs at optimum capacity.
        - Ozone regulation technology shall control ozone production in line with cooking activity.
        - Allows increases in air speed without significant effect on performance.
    - Carbon panels
        - Rigid, bonded, activated carbon panels shall be furnished to remove both base and acid odor molecules.
        - Carbon mass shall be applied at a minimum of 100 lbs. per 1,000 cfm (45.2 kg. per 472 l/s) of exhaust air volume.
        - Panels shall be held in place by gasketed, extruded aluminum tracks arranged in a v-bank configuration.

320.000 WORKMANSHIP

320.010 GREASE FILTER INSTALLATION:

- Install grease filters in accordance with manufacturer's recommendations.

320.020 KITCHEN CANOPY INSTALLATION:

- Install kitchen canopies in accordance with DW/172.

U41 - FAN COIL AIR CONDITIONING

PART 3 SPECIFICATION CLAUSES SPECIFIC TO U41

300.000 PRODUCTS/MATERIALS

300.001 PRESSURE EQUIPMENT DIRECTIVE/PRESSURE EQUIPMENT REGULATIONS:

- All equipment and assemblies which fall within the scope of the Pressure Equipment Directive (PED) 2014/68/EU must be tested by the manufacturers and be certified as compliant with the directive. Such compliance shall be evidenced by displaying the appropriate CE Mark on the equipment and assemblies.
- Only relevant equipment and assemblies certified as compliant will be permitted under this specification and any substitution put forward must also be compliant with the directive.

300.015 ECODESIGN REQUIREMENTS FOR FAN COIL UNITS:

- Provide product information / instruction manuals in accordance with EU Regulation 2016/2281 including information on disassembly, recycling and/or disposal.

300.020 FAN COIL UNIT NOISE LEVELS:

- Sound power level measurements
    - Determine the sound power levels of fan coil units in accordance with:
        - BS EN 16583
            - Acoustic test facilities / measurement in accordance with BS EN ISO 3741 or BS EN ISO 3744 or BS EN ISO 3745 or relevant parts of BS EN ISO 3743, or relevant parts of BS EN ISO 9614.

300.030 FAN COIL UNITS:

- Comply with section Y92A for specifications of starters and VSD
- Performance - ensure manufacturer's ratings comply with
    - BS EN 1397 for the thermal and volumetric performance of air free delivery and air ducted cooling units.
    - Eurovent standard 6/3 Thermal Test Method for Fan Coil Units.
    - Eurovent standard 8/2 Acoustical Testing of Fan Coil Units in Reverberation Room.
    - Eurovent standard 6/10 Air Flow Test Method for Ducted Fan Coil Units.
    - Eurovent standard 6/11 Thermal Test Method for Ducted Fan Coil Units.
    - Eurovent standard 8/12 Sound Test Method for Ducted Fan Coil Units.
- Casings
    - Fabricate from galvanized mild steel sheets and stiffeners without sharp edges. Incorporate fixing lugs. Protect against corrosion internally and externally. Do not use self tapping screws.
    - Provide space within casing for pipework, ductwork and valves.
- Mounting
    - Concealed
- Finish
    - Stoved primer.
- Insulation

- Use thermal and acoustic insulation with surface finish to protect against product migration and all edges positively sealed. Thermal and acoustic insulation to be class O to BS 476 and BS ISO 5660-1, installed internally to casing and integral discharge plenum.

- Access - provide ready access to filter, fan and motor and any valves and controls.
- Fan coil unit components
    - Fans
        - Type
            - Double inlet, double width forward curved centrifugal fan with direct coupled motor and aluminium impellers statically balanced and isolated from casing by AV mounts.
            - Single inlet, single width forward curved centrifugal fan with direct coupled motor and aluminium impellers statically balanced and isolated from casing by AV mounts.
        - Scrolls manufactured from galvanised mild steel, complete with forward curved multi-bladed aluminium or galvanized steel impellers.
    - Motor
        - Permanent split capacitor
        - Electronically commutated direct current type EC/DC, rated for continuous operation with inbuilt overload protection devices and shall be capable of performance control via a 0-10 Volt dc signal to give infinitely variable speed control
            - Provide pressure independent operation facilities
    - Filter
        - Return air filter of nylon or other synthetic filter media in a metal frame, tested to BS EN 779.
        - Filter removal/withdrawal details
        - Filter Classification to BS EN ISO 16890-1
    - Coils
        - Form cooling batteries of copper tube with aluminum fins. Minimum tube thickness 0.3mm, minimum fin thickness 0.1mm.
    - Fix cooling batteries to prevent air leakage around coil.
    - Fit a manual air vent and drain cock on each coil
    - Drip-tray
        - Drip-tray under coil and under control valve where fitted, fabricated from non-corrosive material or protected against corrosion with external faces insulated to prevent condensation with class O material to BS 476 and BS ISO 5660-1
    - Drain Connections
        - Ensure connection to drip tray is flush with bottom of drip tray.
        - Fit a screwed plug connection to drip-tray.
        - Fit a drain line
    - Accessories
        - Controls and commissioning valves
            - 2 port full stroke Pressure Independent Control Valves (PICV)

- Condensate pump
- Anti-vibration mountings
- Flexible hoses for flow and return connections with push fit quick release connections at each end.

310.000 WORKMANSHIP

310.010 INSTALLATION:

- Store fan coil units on-site in a clean, dry environment and seal/cap duct and pipe connections and filters.
- Install in accordance with manufacturer's recommendations to give a neat appearance, with supports out of view.
- Ensure equipment is firmly fixed and level.
- Ensure the fan coil unit is level or angled slightly towards the condensate tray outlet connection to facilitate correct condensate removal from the unit.
- Ductwork installation
    - Flexible ductwork should be in accordance with BS EN 13180 and only be used for the final connections to diffusers. Installation to comply with BSRIA BG 43/2013 and clause Y30.4015.
- Connect pipework to fan coil units using suitable flexible hoses of the same size as the installation pipework. Hoses to be in accordance with BSRIA BG 4/2004: Flexible Hoses Standard and installed in accordance with BSRIA COP 11/2002.
- Installation pipework should be supported independently from the fan coil unit.

U60 - AIR CONDITIONING UNITS

300.000 PLANT AND EQUIPMENT

300.001 PRESSURE EQUIPMENT DIRECTIVE/PRESSURE EQUIPMENT REGULATIONS:

- All equipment and assemblies which fall within the scope of the Pressure Equipment Directive (PED) 2014/68/EU must be tested by the manufacturers, and be certified as compliant with the Directive. Such compliance shall be evidenced by displaying the appropriate CE Mark on the equipment and assemblies.
- Only relevant equipment and assemblies certified as compliant will be permitted under this specification, and any substitution put forward must also be compliant with the Directive.

300.003 SAFETY STANDARDS AND REGULATIONS:

- Comply with BS EN ISO 12100, BS EN 378 and BS EN 12693.
- Comply with F-Gas Regulations and relevant DEFRA guidance documents.
- Pipe discharges from safety valves to be located at a safe point away from fresh air intakes or openable windows (external to building for plant in enclosed plant rooms). The discharge point shall be such that persons and property are not endangered by a release of the refrigerant and be well away from any fresh air intakes or openable windows.

300.004 EQUIPMENT FOR REFRIGERATION PLANT:

- Comply with the following standards for equipment that make up the packaged plant:
  - Refrigerating compressors
    - Performance testing in accordance with BS EN 13771-1 and BS EN 12900.
    - Use lubricating oils in accordance with BS 2626, BS ISO 6743-3 and manufacturer's recommendations.
    - Safety of motor-compressors to BS EN 60335-2-34
  - Heat exchangers - Tubing for heat exchangers and their internal connecting to be round copper tubes, smooth or inner finned to BS EN 12735-2
  - Refrigerating condensers - Performance testing in accordance with BS EN 13771-2 and BS EN 13215
  - Motors
    - Comply with EC Regulation 640/2009 and amendment EU Regulation 4/2014 with regard to ecodesign requirements for electric motors.
    - BS EN 60034-30-1 and BS EN 50347 as applicable to 3-phase cage-induction motors.
    - Comply with section Y92A for specifications of starters and VSD
    - Efficiency
      - For VSD motors: Efficiency class IE2, reference Y92.2025A
  - Pressure vessels to relevant parts of BS EN 13445 and BS EN 14276-1 for general requirements for material, design, manufacturing, testing and documentation

300.015 ECODESIGN / EER REQUIREMENTS FOR AIR CONDITIONERS:

- Equipment to be in accordance with The Energy Related Products Regulations 2010 as amended.

- Fans incorporated into plant with electric input between 125W and 500kW to comply with EU Regulation 327/2011.
- Ecodesign Requirements
    - Cooling Only Units
        - Units with a rated capacity of up to 12kW to comply with EU Regulation 206/2012. Other plant to comply with EU Regulation 2016/2281, including Seasonal Space Cooling (or Heating) Energy Efficiency (SCEE / SHEE) and product information / instruction manuals information on disassembly, recycling and/or disposal.
    - Heating or Cooling/Heating Units
        - Units with a rated capacity of up to 12kW to comply with EU Regulation 206/2012.
- The full load Energy Efficiency Ratio (EER) of plant shall be in accordance with BS EN 14511.

300.030 ROOF MOUNTED AIR CONDITIONING UNIT:

- Provide packaged roof mounted air conditioning unit complete with integral condenser.
- Type
    - Cooling Only
- Duty
    - Refrigerant
        - R407C or R410A.
- European / British standards
    - Relevant parts of BS EN 378 for safety and environmental requirements of refrigerating systems.
    - BS EN 12693 for safety and environmental requirements of positive displacement refrigerant compressors.
    - BS EN 60335-2-40 for safety of air-conditioners and heat pumps.
    - Classification, testing / operating requirements, marking and instructions.
        - BS EN 14511-1 for terms and conditions
        - BS EN 14511-2 for test conditions
        - BS EN 14511-3 for test methods
        - BS EN 14511-4 for requirements
- International standards
    - BS ISO 13253 for ducted air-cooled air conditioners and air-to-air heat pumps
- Casing - Manufacturer's standard weatherproof construction
- Finish
    - Corrosion-protection coating
- Condensate drain pan
    - Stainless steel
- Access - Provide access to filter, fan and motor.
- Coil
    - Refrigerant coil

        - Direct expansion coil with equalizing-type vertical distributor
        - Seamless copper tubes in galvanized steel casing with aluminum fins
        - Coil shall have epoxy coating
    - Electric heating coil - Manufacturer's standard construction, factory wired for single-point wiring connection, with overcurrent and overheat protection devices. Provide 3-way modulating control valve.
- Filter indoor to BS ISO 16890-1
    - ISO ePM2.5, $E_m \geq 65\%$
- Filter outdoor
    - Washable.
- Insulation - Provide thermal and acoustic insulation.
- Controls
    - On/off switch.
    - Remote checking and adjusting.
    - Variable speed setting.
    - Variable temperature.
- Integral Compressor
    - Supply an inverter type fully hermetic compressor and fan mounted within the casing of the air conditioning unit.
    - Provide compressor complete with suction and delivery valves, service connections and high and low pressure switches.
    - Mount compressor on anti-vibration mountings to prevent the transmission of vibration.
    - Fit a crankcase heater to prevent migration of refrigerant.

300.035 SPLIT COIL ROOM AIR CONDITIONING UNIT:

- Provide room unit as part of split coil air conditioning system.
- Type
    - Cooling Only
    - Heat Pump
- For outdoor unit specification, refer to clause 300.050
- Mounting
    - Concealed horizontal.
- Duty
    - Refrigerant
        - R410A.
- European / British standards
    - Relevant parts of BS EN 378 for safety and environmental requirements of refrigerating systems.
    - BS EN 12693 for safety and environmental requirements of positive displacement refrigerant compressors.
    - BS EN 60335-2-40 for safety of air-conditioners and heat pumps.
    - Classification, testing / operating requirements, marking and instructions.

        - BS EN 14511-1 for terms and conditions
        - BS EN 14511-2 for test conditions
        - BS EN 14511-3 for test methods
        - BS EN 14511-4 for requirements
- International standards
    - BS ISO 5151 for non-ducted air-cooled air conditioners and air-to-air heat pumps.
    - BS ISO 15042 for multi-split systems, modular multi-split systems and modular heat recovery multi-split systems.
- Casing
    - Manufacturer's standard.
    - Removable panels for service
- Finish
    - Manufacturer's standard.
- Coil
    - Refrigerant coil
        - Direct expansion coil with capillary restrictor
        - Seamless copper tubes mechanically expanded into aluminum fins
- Access - Provide access to filter, fan and motor.
- Room side fan
    - Tangential with direct coupled motor.
- Filter
    - Washable.
- Grille type
    - Manufacturer's standard.
    - Motorised paddle in exit air stream.
- Insulation - Provide thermal and acoustic insulation.
- Controls
    - Display
        - Operating.
        - Program dry function.
        - Defrost/hot start.
        - Filter dirty.
        - Temperature setting.
        - Timer.
        - Air flow.
        - Fault.
    - Auxiliary contacts to wire to external source
        - Alarm/fault.
        - Temperature setting.
        - Start/stop.
    - Controls type

- Temperature setting.
- Timer settings (units of 1 hr to 72 hr).
- Air flow setting.
- Air flow direction adjustment.

- Condensate drainage
  - Condensate pump within unit.

300.065 COMPUTER ROOM AIR CONDITIONING UNITS:

- For outdoor unit specification, refer to clause 300.070
- Type
  - 2 independent cooling circuits type
  - Classification, testing / operating requirements, marking and instructions.
    - BS EN 14511-1 for terms and conditions
    - BS EN 14511-2 for test conditions
    - BS EN 14511-3 for test methods
    - BS EN 14511-4 for requirements
- Controls
  - Units to include all necessary controls and control valves to operate as a self-contained fully functioning plant.
  - Close control
  - BMS interface
- Casing
  - Provide manufacturer's standard casing.
- Finish
  - Manufacturer's standard finish.
- Access
  - Provide access to components requiring regular maintenance via
    - Access panels with special locks.
    - Hinged access doors.
- Mounting - Floor.
- Components
  - Fans
    - Provide fans, motor and drive assembly mounted on a base frame. Provide anti-vibration mounts to prevent transmission of vibration to unit
    - Supply direct drive backward curved plug fan with EC motor.
  - Cooling section
    - Provide cooling coil manufactured from copper tube with aluminium fins.
    - Provide stainless steel condensate drain pan with drain connection. Provide each coil section with separate drain pan and drain connection.
  - Chilled water systems

- Provide cooling coils complete with isolating valves.
- Provide cooling coils complete with control valves.
- Provide coils with air vent and drain.

- DX refrigerant based systems
  - Provide scroll compressors.
  - Compressor details
    - Supply a fully hermetic compressor and fan mounted within the casing of the air conditioning unit. Provide compressor complete with suction and delivery valves, service connections and high and low pressure switches. Mount compressor on anti-vibration mountings to prevent the transmission of vibration. Fit a crankcase heater to prevent migration of refrigerant.
    - Provide inverter motor drive for compressor
  - Refrigerant
    - R32.
    - R410A.
- Humidifier
  - Provide a packaged steam generator humidifier complete with safety controls and automatic blow down cycle.
  - Provide ultrasonic humidifier.
- Filters
  - Tested to BS EN ISO 16890-2, 16890-3 and 16890-4.
  - Filter class to BS EN ISO 16890-1

- Ancillaries and accessories
  - Isolation valves
  - Air shut off dampers
  - Water leak detection
  - Condensate pump with high level and fault alarms for BMS monitoring
  - Base stand for false floor depth

300.071 SPARE PARTS FOR INDOOR UNITS:

- Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - Filters: Furnish 1 spare filter[s] for each filter installed.
  - Fan Belts: Furnish 1 spare fan belt[s] for each unit installed.

300.110 REFRIGERANT PIPING SYSTEM:

- Pipe Material
  - Seamless copper tube to BS EN 12735-1
    - Material condition (or temper)
    - To be selected by the equipment manufacturer or the specialist pipework installer to suit the application, maximum operating temperature and pressure and refrigerant.

- Comply with the requirements of the BS EN 14276-2 and relevant parts of BS EN 378
- Jointing
    - Brazing - comply with British Refrigeration Association (BRA): Jointing of Copper Pipework for Refrigeration Systems - Specification & Procedures for Manual Torch Brazing and Brazer Assessment.
- Support
    - Support all pipework and controls cabling throughout their length using cable tray, firmly fixed to the building fabric.
    - Perforated cable tray
        - Flanged.
        - Return.
    - Perforations and thickness - Manufacturer's standard.
- Fittings
    - Use factory made fittings throughout of same material type, pattern, finish and thickness as tray.

300.130 PIPEWORK INSULATION

- Insulate entire length of pipework for thermal insulation and to avoid contact between copper and galvanising of support tray.
- Closed cell nitrile rubber preformed flexible sections
    - CFC free.
    - Install un-split wherever possible.
    - Use manufacturer's standard glue for jointing.
    - Ensure vapour barrier is maintained on
        - All pipework.
- Protection
    - Paint
        - Manufacturer's standard colour.
    - Wrap fittings and valves with same insulation as pipework.
    - Provide aluminium valve boxes.
- Insulation thickness (mm) : Manufacturer's standard

310.000 PLANT AND EQUIPMENT WORKMANSHIP

310.010 PLANT AND EQUIPMENT INSTALLATION:

- Install equipment in accordance with manufacturer's recommendations.
- Heat Pumps
    - Install heat pump system in accordance with manufacturer's recommendations and BS EN 14336.

310.020 REFRIGERANT PIPEWORK INSTALLATION:

- Arrange all exposed pipe runs to present neat appearance, parallel with other pipe or service runs and building structure.
- Ensure all vertical pipes are plumb or follow building line. Provide lifting loops where called for by system manufacturer.
- Space pipe runs in relation to one another, other services runs and building structure, allow for specified thickness of thermal insulation and ensure adequate space for access to pipe joints etc.
- Take precautions to prevent the discharge of refrigerant gases to atmosphere.
- All refrigerant pipework insulation at low level or in locations where mechanical damage could occur or which could be damaged by UV radiation shall be suitably protected.

320.000 COMMISSIONING

320.010 COMMISSIONING REQUIREMENTS:

- Put the system to work.
- Demonstrate that specified air quantities are attained plus or minus: 10%
- Keep a systematic record of commissioning results.
- Heat Pumps
    - Commission plant and systems served in accordance with manufacturer's recommendations and Section 6 of BS EN 15450

V0 - BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. This Section includes the following:

1. General provisions applicable to Division V, W and Y work and other Sections of the Specification that refer to this Section.
2. Supporting devices for electrical components.
3. Electrical identification.
4. Covers, brackets and supports.
5. Electricity-metering components.
6. Concrete equipment bases.
7. Cutting and patching for electrical construction.
8. Touchup painting.

B. Electrical Work, unless otherwise specified, includes the supply, installation, testing and commissioning of the complete electrical systems, equipment and materials shown on the Drawings and/or described in the Specification together with all associated ancillary work, support work and builder's work required to achieve full functionality as per the design intent.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Regulations: Carry out electrical work in accordance with the current issue of the local codes of practice, local power authority regulations and Requirements for Electrical Installations – IET Wiring Regulations (BS 7671) as published by the Institution of Engineering and Technology and IEC 60364 Standards where not in contradiction with the local codes of practice and regulations, herein referred to collectively as 'the Regulations'.

B. Conflict: Should an instance occur in this Specification or on the Drawings in which material or construction methods called for is less than minimum requirement of the Regulations, immediately inform the Engineer in writing. Consequent to Engineer's approval, supply the materials and perform the work as though called for to minimum code standards.

C. Standards: Unless otherwise specified, equipment and materials shall be manufactured and installed in compliance with the relevant recommendations of the following or other equal and approved standards:

1. IEC: The International Electro-technical Commission.
2. ISO: The International Standardization Organization.
3. CENELEC: European Committee for Electrotechnical Standardization.
4. CCITT: The International Telephone and Telegraph Consultative Committee.
5. CCIR: The International Radio Consultative Committee.
6. CISPR: The International Special Committee on Radio Interference.
7. IET: The Institution of Engineering and Technology.
8. BS: British Standards.
9. ENDE: Empresa Nacional de Distribuição de Electricidade.
10. CIE: International Commission of Illumination.
11. ITU: International Telecommunication Unit.
12. NEBS: Network Equipment Building System.

D. In case of contradiction between enforced and relevant local regulations and International Standards, the most stringent requirements shall prevail.

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110.020 PROJECT/SITE CONDITIONS

A. Climatic Conditions at Project's Site:

1. Altitude: 100 m above sea level.
2. Maximum ambient temperature: 35 degrees C (in the shade).
3. Minimum ambient temperature: 14 degrees C.
4. Maximum relative humidity: 85 %.
5. Equipment shall be capable of withstanding the project environmental conditions specified here below encountered at the installed location without mechanical or electrical damage or degradation of operating capability, unless otherwise specified. For devices located in harsh environments such as interior uncontrolled or exterior environments, the Contractor shall provide the necessary housings or enclosures to ensure proper equipment operation and performance.

    a) Interior Environment: System components, installed in interior environments shall be rated for continuous operation in ambient conditions of 10 to 40 deg C dry bulb and 20 to 90 percent relative humidity, noncondensing.
    b) Exterior Environment, Under Direct Sunlight: System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of 5 to 55 deg C dry bulb and 10 to 100 percent relative humidity, condensing, when exposed to winds up to 160 km/h.
    c) Exterior Environment, Under Shade: System components installed in locations exposed to weather shall be rated for continuous operation in ambient conditions of 5 to 40 deg C dry bulb and 10 to 100 percent relative humidity, condensing, when exposed to winds up to 160 km/h.

6. All electrical equipment including transformers, switchgears, cables, relays, lighting fixtures, motors, etc. shall be designed or derated for continuous and trouble-free service under the following climatic conditions:

    a) Interior Environment – where installed indoors.
    b) Exterior Environment – where installed outdoors.

7. Where design and operating conditions, different from the above are required for particular equipment, they are described in the specification of the equipment concerned.
8. Equipment, apparatus, material accessories installed outdoors shall be corrosion and salinity proof. UV stabilized requirement shall be applied for outdoor installations and their surface finish and due certification shall be provided by manufacturer as necessary.

120.000 SYSTEM DESCRIPTION

120.010 SCOPE OF WORK

A. The scope of electrical works shall include, but shall not be necessarily limited to the following:

1. Power Service and Distribution consisting of:

    a) Medium voltage distribution:

        1) MV switchgear & MV cabling.
        2) Power Transformers.
        3) Utility metering.
        4) Low voltage distribution network:

    b) Main distribution boards.
    c) Distribution panels.
    d) Final branch circuit panelboards (LPs, PPs, etc.).
    e) Automatic transfer switches.
    f) Motor control centers / panels.
    g) Power factor correction capacitors.
    h) Feeders, sub-feeders and wires.

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i) Conduits, cable trays, wireways and supporting systems.
j) Underground ducts and raceways.

2. Standby emergency power plant:

a) Diesel generator sets.
b) Synchronizing boards.

3. Lighting and small power installations:

a) Functional and decorative indoor lighting.
b) Building facade lighting.
c) Landscape lighting.
d) Exterior lighting.
e) Emergency lighting and exit signs.
f) Lighting control and dimming systems.
g) Emergency Central Battery System (ECBS).
h) Wiring devices & miscellaneous equipment.

4. Other electrical systems:

a) Uninterruptible Power Supply,
b) Earthing & Lightning protection systems.

5. Communication, life safety and security systems consisting of:

a) Structured Cabling Network.
b) Data Communications Network.
c) Wireless Data Network.
d) IP-Based Telephony (VoIP).
e) Audiovisual Systems and Equipment.
f) IP Television System (IPTV).
g) IP Public Address System (PAS).
h) Master Clock System.
i) Security Systems:

1) Access and Security Control System (SACS).
2) Security Screening Equipment.
3) Parking Control Equipment.
4) Video Surveillance (CCTV).
5) Fire Detection and Alarm system.

j) Horizontal and Vertical Transportation Systems (HVTS) consisting of:

1) Passenger and service elevators.

120.020 GENERAL

A. POWER SUPPLY

1. The Local Power Authority will provide incoming power supply and connection at 15kV to the location shown on the Drawings.
2. Power Supply: Liaise with the Local Power Authority to confirm:

a) Characteristics of supply and system earthing.
b) Location of incoming supply shown on the Drawings.
c) Space requirements and associated builder's work for the Authority's installations.
d) Make necessary arrangements at the earliest opportunity to ensure connection as and when required, and inform the Engineer in the event of any foreseen delay.

3. kWH-metering: Liaise with the Local Power Authority and provide necessary instrumentation, enclosures and accessories required by them to effect a complete kWH-metering installation.
4. kWH-metering will be at medium voltage unless otherwise shown on the Drawings.
5. Nominal characteristics of power supply and distribution are as follows:

a) Medium voltage: 15 kV, 3-phase, 3 wire .
b) Low voltage: 400 V, 3- phase, 4- wire, solidly earthed neutral.

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c) Frequency: 50 Hz.

6. Distribution systems shall be supplied or derived from the voltage system previously described, as shown on the Drawings, or as otherwise specified.
7. The Contractor shall ensure that system's upstream protection device settings are re-calculated by competent agency and changed as necessary to be compatible with the final approved load conditions.

B. TELEPHONE PUBLIC EXCHANGE LINES

1. The Local Telephone Authority will bring telephone public exchange lines into the premises to the location shown on the Drawings and/or to be agreed with the Authority. Liaise with the Local Telephone Authority to confirm location of connection of public telephone exchange lines into the premises.

C. MOTORS AND OTHER ELECTRICALLY OPERATED EQUIPMENT

1. All electrical work from and including motor control centers / panels to motors and other electrically operated equipment, which is included in Division Y Section "Motor Control Centers", form part of the Electrical Work.
2. Power supply to motors and other electrically operated equipment, which are not connected to a motor control center / panels, is included in the Electrical Work and comprises power supply to terminal box on equipment or nearby disconnecting or starting device, and includes the disconnecting device, if individually provided, including the starting device or combination starter.

D. EQUIPMENT

1. Equipment Spaces and Rooms: Verify that dimensions, structure, ventilating and cooling arrangements and other provisions in equipment spaces and rooms are suitable for installation, operation and maintenance of proposed equipment. Note any discrepancies on the shop and construction drawings.
2. Equipment shall be designed for the system voltage and frequency previously described, unless otherwise specified. Special provisions shall be made for equipment sensitive to power supply frequency and voltage variations and for equipment operated at other voltages/frequencies or by direct current sources.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and Division 01 Specification Sections, apply to this Section.

B. Drawings

1. Equipment locations shown on the Drawings indicate approximate locations and general layout of equipment. Exact and final locations and layouts together with dimensions, weights, mounting methods and accessories, where relevant, shall be shown on Contractor's shop and construction drawings.
2. Symbols: In order to provide sufficient detail and a minimum degree of clarity on the Drawings, the symbols used for various electrical devices, particularly wall mounted devices, take up more space on the Drawings than the device does on the wall. Because of drafting limitations these locations must be considered as being indicative rather than exact physical locations of the devices. The devices shall be installed with prime regard for convenience of operation and the proper usage of the wall space rather than to coincide with the scaled locations of the symbols. In locating the outlets, follow the criteria provided on detail Drawings where provided, and coordinate with furniture. Do not scale from design Drawings.

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3. Wiring layouts shown on the Drawings shall be used as a guide only to defining basic positions, circuiting, loading and switching arrangements. Actual layouts and details of routing of circuits shall be shown on the Contractor's shop and construction drawings.
4. Wiring layouts shown on the Drawings for work not included in the Electrical Work are shown for convenience and reference only.

PART 3 PRODUCTS AND WORKMANSHIP

300.000 MATERIALS

300.010 EQUIPMENT AND MATERIALS

A. Availability: Confirm availability of equipment and materials proposed for use in the work prior to submission for approval. If, after approval, equipment or materials cease to be available, submit alternative items of equal quality and type for approval.

B. Acceptance by Authority: Confirm that proposed equipment and material characteristics where required are compatible with the requirements of the Local Power Authority or other Authorities having jurisdiction and are acceptable to them. Inform Engineer of any modifications necessary to comply with the Local Power Authority's requirements.

C. Manufacturers' Standards: Equipment shall be the latest standard product of the manufacturer. Component parts shall be the product of a single manufacturer, unless otherwise approved and provided that components made by other manufacturers are of a standard design and are interchangeable.

D. Approved Manufacturers: Listing of approved manufacturers in the Specification does not necessarily constitute approval of their standard products as equal to those specified. Ascertain that listed manufacturers are able to supply equipment and material in conformity with the Specification.

E. Factory Assembly: Equipment generally shall be supplied in complete factory assembled units ready for installation on site. Dis-assembly necessary for transportation or other purposes shall be arranged to limit site work to simple re- assembly and inter-wiring of control and power cabling.

F. Storage of Materials: Equipment and materials shall be stored in an approved location, under cover, free from humidity, dust, debris and rodents. Equipment sensitive to heat and humidity shall be kept in climatically conditioned areas until installed and handed over.

G. Defective Equipment: The Employer reserves the right to operate operable defective equipment during the Defects Liability Period until it can be removed from service for repair or replacement.

H. Warranty: Where required by the Specification, provide a warranty, signed by the manufacturer (including his agreement to replace promptly, defective equipment or parts thereof, as instructed by the Engineer) covering materials and workmanship for the period stated in the Specification, starting at substantial completion. Assign the benefits of such warranty to the Employer.

I. Spare Parts: Not later than the date of substantial completion, provide spare parts required by the Specification, together with suitable means of identifying, storing and securing same.

J. Tools and Instruments: Not later than the date of substantial completion, provide sets of tools and instruments required by the Specification, together with suitable means of identifying, storing and securing same.

K. Label and identify all equipment, instruments, control and electrical devices etc. to indicate duty, service or function, to the satisfaction of Engineer. Labels shall be laminated anodized aluminum discs with black surface and white core with incised lettering in English and Portuguese. Alternative methods of labelling may be submitted for approval. Fix labels with non-corrodible screws to equipment, or to adjacent permanent surfaces or as approved by Engineer.

L. Systems used before substantial completion shall have all consumable elements, such as lamps etc. and defective equipment replaced by new, within 7 days prior to the date of substantial completion.

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M. All panels and electrical boards shall have designs permitting easy access of internal components for maintenance and replacement without disturbing other components. All equipment shall be designed for easy and simple operation.

N. Contractor shall be responsible to define the necessary power supplies, taking into account the installed load of chosen equipment and final condition of installation, as well as any other considerations as to allow the proper operation and maintenance of equipment.

300.020 PRODUCTS

A. SUPPORTING DEVICES

1. Material: Cold-formed steel, with corrosion-resistant coating.
2. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.
3. Slotted-Steel Channel Supports: Flange edges turned toward web, and 14-mm diameter slotted holes at a maximum of 50-mm centers in webs.

    a) Channel Thickness: Selected to suit structural loading.
    b) Fittings and Accessories: Products of the same manufacturer as channel supports.

4. Nonmetallic Channel and Angle Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 14-mm diameter holes at a maximum of 200-mm centers in at least one surface.

    a) Fittings and Accessories: Products of the same manufacturer as channels and angles.
    b) Fittings and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.

5. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers.
6. Pipe Sleeves: Schedule 40, galvanized steel, plain ends for indoor installations from both sides and flanged for outdoor installation from any side or penetration of water tanks or similar.
7. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable-iron casting with hot-dip galvanized finish.
8. Expansion Anchors: Carbon-steel wedge or sleeve type.
9. Toggle Bolts: All-steel springhead type.

B. ELECTRICAL IDENTIFICATION

1. Identification Devices: A single type of identification product for each application category. Use colors prescribed by these Specifications.
2. Raceway and Cable Labels: Minimum size of letters for legend and minimum length of color field for each raceway and cable size to meet IEC Standards.

    a) Type: Pre-tensioned, wraparound plastic sleeves. Flexible, preprinted, color-coded, acrylic band sized to suit the diameter of the item it identifies.
    b) Type: Pre-printed, flexible, self-adhesive, vinyl. Legend is over-laminated with a clear, weather- and chemical-resistant coating.
    c) Color: Black letters on orange background.
    d) Legend: Indicates voltage.

3. Colored Adhesive Marking Tape for Raceways, Wires, and Cables: Self-adhesive vinyl tape, not less than 25 mm wide by 0.08 mm thick.
4. Underground Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape with the following features:

    a) Not less than 150 mm wide by 0.102 mm thick.
    b) Compounded for permanent direct-burial service.
    c) Embedded continuous metallic strip or core.
    d) Printed legend that indicates type of underground line.

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5. Tape Markers for Wire: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.
6. Equipment Nameplates: Non-corroding, robust metal, inscribed in English and Portuguese, and firmly fixed to equipment at factory. Nameplates shall indicate name and address of manufacturer, model, serial number, basic characteristics and ratings of equipment and shall include elementary diagrams etc., all in accordance with the Standards. Equipment shall also be further identified after location at site, indicating the nomenclature number as per approval. As a general practice, the identification labels shall be suitably located on adjoining surface or on separate support and not on the electrical device which could be removed and replaced.
7. Color-Coding Cable Ties: Nylon, self-locking type. Colors to suit coding scheme.
8. Engraved-Plastic Labels, Signs, and Instruction Plates: Engraving stock, melamine plastic laminate punched or drilled for mechanical fasteners 1.6-mm minimum thickness for signs up to 129 sq. cm and 3.2-mm minimum thickness for larger sizes. Engraved legend in black letters on white background.
9. Interior Warning and Caution Signs: Preprinted, aluminum, baked-enamel-finish signs, punched or drilled for mechanical fasteners, with colors, legend, and size appropriate to the application.
10. Exterior Warning and Caution Signs: Weather-resistant, non-fading, preprinted, cellulose-acetate butyrate signs with 1-mm, galvanized-steel backing, with colors, legend, and size appropriate to the application. 6-mm grommets in corners for mounting.
11. Fasteners for Nameplates and Signs: Self-tapping, stainless steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.

C. COVERS FOR TRENCHES

1. Covers in electrical rooms and the like, unless otherwise specified or shown on the Drawings, shall be flanged checkered steel plates with angle or channel- section frames, suitably reinforced to support anticipated loads, and finished with zinc chromate primer and two coats gray enamel.

D. BRACKETS, SUPPORTS, RAILS AND TRACKS

1. Brackets, supports, rails and tracks for supporting electrical installations shall be galvanized steel, fixed with expansion bolts of approved size and material. Plastic inserts and lead anchors are not acceptable unless approved for specific light duty installations.
2. Covers shall be suitably dimensioned and matched to provide perfect level surface with flush-mounted lifting handles. Cut edges of trench covers shall be provided with neoprene trims to avoid sharp edges. Cable trench covers shall be supported with additional members at wide spaces.
3. All supports used in external locations, cable trenches and manholes shall be provided with an additional coat of U.V resistant paint, of a color to Engineer’s approval.
4. All fixing hardware used in non-air-conditioned spaces, shall be made of non-corrosive material.

E. CONCRETE BASES

1. Concrete Forms and Reinforcement Materials: As specified in Division E Section " Accessories Cast Into In Situ Concrete."
2. Equipment Foundations and Bases: Reinforced concrete, as approved by Engineer after submission of design calculations. Dimensions, levels and surface finishes shall be suitable for equipment installed, as shown on the Drawings or in accordance with approved shop and construction drawings.
3. Alternatively and where concrete bases are not possible, equipment can be anchored to steel-channel sills 100 mm high (min and as necessary), arranged and sized according to manufacturer's written instructions. Attach by tack welding or bolting. Level and grout sills flush with equipment mounting surface.

F. EQUIPMENT FOR ELECTRICITY METERING BY EMPLOYER

1. Meter: Electronic kilowatt-hour measuring to record electricity used.
2. Meter: Electronic kilowatt-hour/demand measuring to record electricity used and highest peak demand over a time period according to electric utility. Meter is designed for use on the type and rating of circuit indicated for its application.

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a) Kilowatt-Hour Display: Digital liquid crystal.
b) Kilowatt-Demand Display: Digital, liquid crystal type to register highest peak demand.
c) Enclosure to have hasp for padlocking or sealing.
d) Memory Backup: Self-contained to maintain memory throughout power outages of 72 hours, minimum.
e) Sensors: Current-sensing type, with current or voltage output, selected for optimum range and accuracy for the ratings of the circuits indicated for this application.

1) Type: Split core.

G. ANTI-CONDENSATION HEATERS AND VENTILATORS

1. Any major items of electrical equipment which are liable to suffer or be affected in the long term, from internal condensation due to atmospheric or load variations shall be equipped with heating devices suitable for electrical operation at 400 V A.C 50 Hz, single phase of sufficient capacity to raise the internal ambient temperature by 5 deg. C.
2. A humidistat shall be included in the heater circuit. The protected electrical apparatus shall be designed such that the maximum permitted rise in temperature is not exceeded if the heaters are energized while the apparatus is in operation. Where fitted, a suitable terminal box and control switch, with indicating lamp shall be provided and mounted in a convenient accessible position.
3. All such equipment, whether fitted with a heating device or not, shall be provided with suitable drainage and shall be free from pockets in which moisture can collect.

H. ELECTRICAL CONTROL LOCATIONS

1. Equipment may be electrically controlled from a number of different control points as specified in the appropriate sections of the Specification. The control positions shall be designated as follows:

a) Local Control: Located within or adjacent to the item of plant to facilitate maintenance, inspection and emergency operation.
b) Remote Control: Located at a substation control room where specified items of Plant are monitored and controlled by direct wire connection.
c) Supervisory Control: Located at a System Control Centre where principal items of plant at a number of substations are remotely controlled via a telecontrol system.

I. TOUCHUP PAINT

1. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.
2. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

310.000 QUALITY MANAGEMENT

310.010 QUALITY ASSURANCE

A. Comply with related Standards, specified therein.

B. Installations shall be carried out by qualified personnel.

310.020 DELIVERY, STORAGE AND HANDLING

A. Install equipment only in dust-free environment and maintain the condition with protective covering as necessary. If air-conditioning is required, ensure it is available by installation time. In general, ensure that locations are complete and ready to receive equipment.

B. Ensure that rooms where equipment are installed are provided with lockable doors.

310.030 WARRANTY

A. Where required by the Specification, provide a warranty, signed by the manufacturer (including his agreement to replace promptly, defective equipment or parts thereof, as instructed by the Engineer)

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covering materials and workmanship for the period stated in the Specification, starting at substantial completion. Assign the benefits of such warranty to the Employer.

310.040 SPARE PARTS AND EXTRA MATERIAL

A. Not later than the date of Substantial Completion, provide spare parts required by the Specification, together with suitable means of identifying, storing and securing same.

320.000 SUBMITTALS

A. Generally: Submit for approval, manufacturers' technical literature, shop and construction drawings and other information required by the Specification, before ordering equipment or materials and before executing any related work on site.

B. Product Data: Submit for approval detailed product data such as model no., all relevant ratings, country of manufacture, interface details as necessary, covers and supports.

C. Calculations: Submit for approval the manufacturer/supplier calculations for the following systems, prior to ordering/manufacturing the material:

1. Indoor and outdoor lighting distribution, with necessary supporting documents and photometric data of the lighting fixtures proposed and approved by the Contractor.
2. Circuit breakers selectivity and discrimination calculation study for a full selective and discriminated distribution scheme.
3. Voltage drop and short circuit calculations after verification of cable and breaker sizes.
4. Generators sizing calculations.
5. Power factor correction capacitors sizing based on the final approved loads.
6. Battery bank calculations to fulfill the specification requirements provided for the specific equipment.
7. Rating / derating calculations for the specified equipment.
8. Lightning risk assessment and energy coordination studies for surge protection.
9. Harmonic analysis.
10. Earthing.
11. Relay settings.
12. Design calculations associated with communications and security systems engineering, power consumption and heat dissipation, link budget, fiber count, Quality of Service (QoS), redundancy, reliability and service availability.
13. Any required calculation necessary to define component/equipment sizes for the proper operation of the electrical and ELV systems, and to confirm compliance with specified Regulations and Standards.

D. Shop and Construction Drawings:

1. Dimensioned plans and sections or elevation layouts of electrical equipment, as applicable.
2. Shop and construction drawings must demonstrate that the design requirements are understood by indicating all equipment and material proposed to be supplied and installed and by detailing fabrication and installation methods proposed to be used. Shop and construction drawings shall clearly state the name and location of the work, the names of Engineer and Contractor, submission date, cross-references to the Drawings and Specification and the specific reference number, location, service and function of each item.
3. Shop and construction drawings shall be submitted at a scale of 1:50 for general layout plans, and 1:10, or 1:20 as approved by the Engineer for sections, details, elevations, congested layouts, etc. Drawings shall include but not be limited to the following:

    a) Details of electrical installations in conjunction with all trades concerned, showing sleeves and openings for passage through floor structure.
    b) Composite construction drawings fully dimensioned, in metric, showing locations of cables, conduits, bus ducts, shafts, mechanical and electrical equipment rooms, ceiling spaces and all other critical locations

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c) Plans showing equipment layouts including all details pertaining to clearances, access, sleeves, electrical connections, location and elevation of pipes, ducts, conduits, etc.
d) Plans, sections and elevations of electrical spaces to illustrate compliance with Standards for allocation of spaces for maintenance, movement, installation, etc.

4. Single Line Diagrams: Detailed single line diagrams and control schematics clearly indicating all equipment ratings, frame sizes, cable sizes, nomenclature/identification number shall be submitted for the Engineer's approval. The SLD's shall include the MV network as applicable.
5. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.
6. Electrical installation shall be fully rated for the power source and load characteristics as also for the fault conditions expected and protection selectively coordinated for full discrimination, considering the different manufacturers products used in the system.
7. Technical Literature: Include detailed manufacturers' specifications and original catalogues or catalogue cuts, characteristics, model number, application and operating criteria of all equipment and materials, together with other information necessary to satisfy Engineer that proposed equipment and systems are suitable and adequate.
8. List of Proposed Manufacturers: Of all equipment and materials, including all items for which choice of manufacturer is at own discretion, shall be submitted for approval.
9. Assembled Equipment: Any assembled equipment to be supplied for the project shall be assembled by the manufacturer or his authorized assembler. Submit the necessary documents to substantiate the above including the assembler staff training, quality control, etc. The Engineer reserves the right to reject any local assembler if the information submitted is not sufficient. The Engineer's rejection in that respect is final and not subject to discussion.
10. Test Certificates and Reports: Submit manufacturer's type and routine test certificates and reports for equipment and devices. Complete test results shall be submitted in clearly identified and organised booklets, indicating item of equipment, make, model, type, date of tests, type of tests, descriptions and procedures. Include in the test reports the Quality Assurance Certification, the standards to which the equipment comply, and the standards to which the equipment was tested.
11. Factory Testing: Locally manufactured/assembled equipment shall comply with the relevant standards recommendations and shall be witnessed by Engineer, where required in the relevant Specifications Section. If the manufacturer's test certificates/tests are not complying with the standards, then independent laboratory tests shall be carried out on equipment in accordance with the Specification and the Standards, and as required by Engineer. The Engineer's requirements in that respect are final and not subject to discussion.
12. Factory Witness testing: for imported equipment, where specified in the relevant specification sections of the various electrical materials and equipment, is to be witnessed by the Engineer. Selection of equipment for witness test is to be randomly carried out by the Engineer and is to cover all ratings/types to be delivered. Witness test is to include complete routine and function testing along with any other special/ type tests if specified, on all units to be witnessed. Test procedure and program are to be submitted for approval prior to test conduction. Factory witness test is to include for business class air tickets, five stars Hotel full accommodation, transportation and all test expenses for the number of engineers/client representatives as specified in the relevant section.
13. Spare Parts Schedules: Submit with the Tender itemised schedules of spare parts to be provided, as required by the Specification, and state against each item the manufacturer's unit price including packaging and delivery to site.
14. Tools And Instruments Schedules: Submit with the Tender itemised schedules of tools and instruments to be provided, as required by the Specification, and state against each item the manufacturer's unit price including packaging and delivery to site.
15. Labeling Schedule: Submit for approval, prior to installation, a schedule of all equipment and devices to be labeled and the suggested details, lettering, position and fixing methods of each label indicating its application.
16. Samples: Submit samples of all equipment and materials for approval. Major items of equipment for which samples cannot be submitted shall be demonstrated in existing installations or by manufacturer's information, test certificates and reports.
17. As-Built (Record) Drawings: Prior to Substantial Completion, submit Record Drawings certified by the Engineer on installed electrical systems, in accordance with requirements of the

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Specification, Division 01. The As-Built (Record) Drawings, where applicable, shall include data on existing works. The As-Built Records shall be made progressively as the Work proceeds.

18. Submit CVs of electrical Engineers, electrical personnel, and quality personnel, for Engineer's review and approval.

330.000 EXECUTION

330.010 ELECTRICAL EQUIPMENT INSTALLATION

A. Installations Generally:

1. Carry out Electrical Work in accordance with the Drawings, Specification and Regulations, ensuring compliance with design and performance requirements, to provide safe and protected systems with equipment readily accessible for operation, maintenance and repair.
2. Installations shall be complete, ready for operation and fully integrated and coordinated with all other work.
3. Provide accessories necessary to complete the installations, of the types specified or recommended for the purpose by the manufacturer of the equipment or accessories.

B. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.

C. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.

E. Right of Way: Give to raceways and piping systems installed at a required slope. Generally, all cabling, power conductor routing shall be located above any piping, unless specifically approved otherwise.

330.020 ELECTRICAL SUPPORTING DEVICE APPLICATION

A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.

B. Dry Locations: Steel materials.

C. Support Clamps for PVC Raceways: Click-type clamp system.

D. Selection of Supports: Comply with manufacturer's written instructions.

E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least three or 90-kg concentrated load, whichever is more stringent.

330.030 SUPPORT INSTALLATION

A. Install support devices to securely and permanently fasten and support electrical components.

B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.

C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.

D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.

E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.

F. Install 6-mm- diameter or larger threaded steel hanger rods, unless otherwise indicated.

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G. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.

H. Simultaneously install vertical conductor supports with conductors.

I. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 600 mm from the box.

J. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.

K. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.

L. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:

1. Wood: Fasten with wood screws or screw-type nails.
2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
3. New Concrete: Concrete inserts with machine screws and bolts.
4. Existing Concrete: Expansion bolts.
5. Instead of expansion bolts, threaded studs driven by a powder charge and provided with lock washers may be used in existing concrete.
6. Steel: Welded threaded studs or spring-tension clamps on steel.
7. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
8. Light Steel: Sheet-metal screws.
9. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

330.040 IDENTIFICATION MATERIALS AND DEVICES

A. Comply with BS 822 and IEC 60034-8.

B. Install at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations indicated in the Contract Documents or required by codes and standards. Use consistent designations throughout Project.

D. Self-Adhesive Identification Products: Clean surfaces before applying.

E. Identify raceways and cables with color banding as follows:

F. Bands: Pre-tensioned, snap-around, colored plastic sleeves or colored adhesive marking tape. Make each color band 50-mm wide, completely encircling conduit, and place adjacent bands of two-color markings in contact, side by side.

G. Band Locations: At changes in direction, at penetrations of walls and floors, at 15-m maximum intervals in straight runs, and at 8-m maximum intervals in congested areas.

H. Colors: As follows:

1. Fire Alarm System: Red.
2. Security System: Blue and yellow.
3. Telecommunication System: Green and yellow.

I. Tag and label circuits designated to be extended in the future. Identify source and circuit numbers in each cabinet, pull and junction box, and outlet box. Color-coding may be used for voltage and phase identification.

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J. Install continuous underground plastic markers during trench backfilling, for exterior underground power, control, signal, and communication lines located directly above power and communication lines. Locate 150 to 200 mm below finished grade. If width of multiple lines installed in a common trench or concrete envelope does not exceed 400 mm, overall, use a single line marker.

K. Install warning, caution, and instruction signs where needed to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.

L. Install engraved-laminated emergency-operating signs with white letters on red background with minimum 9-mm- high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

M. Labels: Labels shall be provided inside the boxes or cubicles to describe the functions of the various items of equipment. Where the cubicle is divided into compartments each door shall have an external label to identify the compartment.

330.050 FIRE STOPPING

A. Apply fire stopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly. Fire stopping materials and installation requirements are specified in Division P Section "Fire Stopping Systems."

330.060 CABLE SEGREGATION AND FIRE RISK

A. All cables shall be routed and connections designed to reduce fire risk, outage and damage to other plant and buildings.

B. Cables shall be segregated to reduce damage if fire occurs and avoid faulty operation of equipment due to induced voltages as follows:

1. Control and protection cables shall be separated from power cables to avoid damage in the event of a power cable fault.
2. Telephone, communication, analogue and digital system cables shall not be at any point less than 300 mm away from power cables, unless otherwise required by relevant Standards and Regulations.
3. All cable holes through walls and floors shall be sealed with approved silicone foam fire seals or other approved materials after the cables have been installed and the cost thereof is deemed to be included in the Contract.

C. Each cable shall be run in one continuous length, straight through joints will not be permitted unless specifically authorized by the Engineer in writing.

D. Wherever cables/wires are routed with a likelihood of these being exposed to high temperature, they shall be provided with additional “heat resistant” sleeves to Engineer’s approval.

330.070 CONCRETE BASES

A. Construct concrete bases of dimensions indicated or otherwise required, but not less than 100 mm larger, in both directions, than supported unit. Follow supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated. For concrete and reinforcement characteristics, refer to Division E Section " Accessories Cast Into In Situ Concrete."

330.080 SUPPORT FRAMES FOR SWITCHGEAR

A. Support frames for switchgear located over cable trenches, where shown on the Drawings or required by equipment design, shall be installed prior to pouring concrete.

330.090 HOLES AND ANCHORS

A. Drilling for anchor bolts shall be carried out using appropriate electric drills and in approved positions.

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B. Holes and chases in in situ concrete shall be cast in. Do not cut hardened concrete or drill holes larger than 10-mm diameter without prior approval.

C. Holes and Chases in Pre-cast Concrete: do not cut or drill pre-cast concrete without prior approval.

D. Holes in Structural Steelwork: Do not cut or drill structural steelwork without prior approval.

E. Holes and chases in masonry must not exceed:

1. Size of holes: 300-mm square.
2. Depth of vertical chases: 1/3 wall thickness or, in cavity walls, 1/3 leaf thickness.
3. Depth of horizontal chases: 1/6 wall or leaf thickness.

F. Cutting Masonry:

1. Ensure mortar is fully set before commencing.
2. Cut carefully and neatly, avoiding spalling, cracking or other damage to surrounding structure.
3. Keep holes to smallest practicable size and do not exceed specified dimensions.
4. Cut chases in straight lines and horizontally and vertically only; do not set back to back; offset by a distance not less than wall thickness.

G. Preformed Holes in Masonry: Submit proposals for bridging over holes for ducts etc. which exceed 450-mm width.

330.100 CUTTING AND PATCHING

A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Before start of work, re-confirm from existing “As-builts” the locations of existing services in the area and obtain approval for work notification. Perform cutting by skilled mechanics of trades involved.

B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing fire stopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

330.110 FIELD QUALITY CONTROL

A. Inspect installed components for damage and faulty work, including the following:

1. Supporting devices for electrical components.
2. Electrical identification.
3. Electricity-metering components.
4. Concrete bases.
5. Cutting and patching for electrical construction.
6. Touchup painting.

B. Test Employer's electricity-metering installation for proper operation, accuracy, and usability of output data.

1. Connect a load of known kW rating, 1.5 kW minimum, to a circuit supplied by the metered feeder.
2. Turn off circuits supplied by the metered feeder and secure them in the "off" condition.
3. Run the test load continuously for eight hours, minimum, or longer to obtain a measurable meter indication. Use a test load placement and setting that ensure continuous, safe operation.
4. Check and record meter reading at end of test period and compare with actual electricity used based on test load rating, duration of test, and sample measurements of supply voltage at the test load connection. Record test results.
5. Repair or replace malfunctioning metering equipment or correct test setup; then retest. Repeat for each meter in installation until proper operation of entire system is verified.

C. Ensure that all warning signs and signages as dictated by the regulations are in place and the room doors locked, once equipment is energized.

D. Field tests shall, in addition to those specified by regulation, specifically include the following:

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1. Insulation resistance tests for all parts of the electrical system, irrespective of voltage class and shall include individual measurement between the various live conductors as also between the individual live conductors and ground.
2. Earthing resistance at each equipment.
3. Loop impedance of each circuit.
4. Earth leakage protection device test.

330.120 REFINISHING AND TOUCHUP PAINTING

A. Refinish and touch up paint. Paint materials and application requirements are specified in Division M Section "Painting and Clear Finishing."

1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

330.130 CLEANING

A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.

B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

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V10A - PACKAGED ENGINE GENERATORS

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. This Section includes emergency power plant installation comprising the following:

1. Diesel generating set(s), with associated control panel with decentralized synchronization functionality, auxiliaries, exhaust system, start-up system, cooling system, fuel system, batteries and charger etc.
2. Fuel storage and transfer system
3. Instrumentation, protection and control equipment
4. Outdoor enclosure
5. Manually operated overhead hoist
6. Soot Filter
7. Inter-plant cabling and wiring
8. Earthing.
9. Connection to BMS system, including interface elements such as relays, transducers, etc. as detailed in Division 23 Specification Sections BMS schedules and /or shown on the Drawings.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Standards: Equipment and component parts shall comply with the following standards:

1. ISO 3046.
2. ISO 8528.
3. IEC 60034.
4. IEC 60085.
5. CISPR.

Equivalent NEMA, ANSI and IEEE standards where such standards meet with or exceed the ISO and IEC Standards.

120.000 SYSTEM DESCRIPTION

120.010 PLANT DESCRIPTION

A. Performance Class: Diesel generator set shall be class G2 (20% voltage drop / free drop at 100% loading) to ISO 8528-1.

B. Generator Set Assembly: Compact package type, with all equipment mounted on one rigid steel bed frame suitable for skidding. Radiator shall be mounted on the set or remotely as shown on the Drawings. Design shall permit easy operation, maintenance and repair.

C. Vibration reduction shall be achieved by appropriate design and careful balancing at factory. Compact set shall have approved anti-vibration isolators of steel spring or resilient neoprene between rotating equipment and bed-frame, limiting transmission of vibration to building to a maximum of 0.04 mm amplitude throughout the operating vibration frequency range.

D. Noise reduction shall be achieved by approved methods at source of noise, including all necessary acoustic louvers, inlet and outlet air attenuators, residential exhaust silencer(s), acoustic treatment of the room walls, floors, doors and ceiling, etc. with sound level measured at 1 m in any direction outside the room limited to 80 dBA in accordance with ISO standards for residential areas. Generator supplier to coordinate with the main contractor for the required installations.

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E. Sand trap louvers: generator room louvers shall be of approved sand trap type if required on the drawings or recommended by the Manufacturer. Contractor to coordinate with the building works for the required installations.

F. Cold Starting: Engine shall be fully equipped to start and pick up initial load specified at specified minimum ambient temperature. Provide coolant heater.

1. Cold starting aids, such as engine jacket water heater, lubricating oil heater, intake-air heater, battery and all devices, accessories, connections, thermostatic switches and off-duty disconnects with pilot lights and necessary protection, shall be supplemented as recommended by the manufacturer and approved.

G. Equipment ratings shall be as shown on the Drawings or the next higher standard ratings provided by the manufacturer. Ratings shall be net prime power (PRP) to ISO 8528-1 with varying load for unlimited number of hours per year and with 10% overload capability for 1 hour every 12 hours to ISO 3046-1, excluding fan and any auxiliaries, auxiliary drives and losses, delivered at specified frequency, voltage and power factor and under worst climatic conditions on site.

120.020 DIESEL GENERATOR SET

A. Components: Set shall basically consist of diesel engine, brushless synchronous generator with direct flexible coupling to engine and single or parallel control cubicle as required and shown on the Drawings.

B. Governing shall conform with ISO 3046-4, electronic type governor with limits of speed control as specified below.

C. Starting and Stopping: When in the automatic mode the set shall start and stop automatically by a signal sensed through an auxiliary contact in the load transfer switchgear. The set shall stop, after an adjustable cool- down period (2 - 30 minutes).

D. Duty: Generator shall reach full speed within 10 seconds from start impulse and accept immediately the first step load to ISO 8528-5 (load being mixed, steady and inductive, with motor starting loads as shown on the Drawings). Transient voltage variation shall not exceed 20% under any step-load application for which the system is intended, up to full rated load, recovering to within +/-2% within a few cycles. For parallel synchronized generators, life safety / life support loads shall be energized once the first generator starts within 10 seconds total time from receiving the impulse start signal without waiting for the other generators to synchronize and connect to bus.

E. Failure To Start: Should engine fail to start following a start impulse, the system shall come to rest for a few seconds. Two further starting attempts shall be automatically made with intermediate 20-second maximum periods of rest. Should the set fail to start after three attempts, an alarm shall sound and a 'start failure' signal illuminate.

F. Hand operation shall be possible for testing or normal operation through a test/manual/off/auto selector switch.

G. Regular Exercising: While on 'auto', the set shall start regularly and automatically every week and shall operate for 30 minutes before stopping.

120.030 DIESEL ENGINE AND AUXILIARIES

A. Design: Diesel engine shall be designed for type of load and application required. Engine and governor shall be selected to meet operating requirements and response specified.

B. Engine Type: Compression-ignition type, with direct solid-injection, turbo-charged after-cooled, for ratings over 100 kW, water cooled, with air-cooled radiator inline or V-type cylinder arrangement suitable for direct coupling to driven machine.

C. Engine Cycle: 4-stroke cycle.

D. Engine Speed: 1500 rpm.

E. Type of Fuel: Light fuel diesel oil.

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F. Fuel System: Engine shall be designed for operating with locally available diesel fuel and have documentation to verify this.

G. Engine rating shall be such that alternator can deliver net specified rated output as specified earlier, with temperature rise not exceeding rise allowed by the Standards.

H. Accessibility: It shall be possible to:

1. Remove rocker-box covers without disturbing fuel injection pipes or other components.
2. Remove and replace pistons and piston rods, liners, big and small end shells and caps without dismounting engine.
3. Bar engine over by hand for spill timing check and adjustment.

I. Measuring Instruments: Engine mounted instruments shall include, at least, water temperature gauge, lubricating oil temperature gauge and pressure gauge, speedometer and running time meter. It shall be possible to measure, with extra instrumentation, coolant temperature at lower end of radiator, air depression after air filter, air boost and temperature using methods recommended by manufacturer. Instrument accesses shall be normally sealed by threaded blanking caps. Speed shall be sensed via a magnetic.

J. Cooling System: Engine shall be water cooled with gear- driven water pumps. System shall be pressurized, with heavy-duty tropical radiator cooled by reverse flow fan. Radiator shall be set mounted or remote as shown on drawings. Remote radiators, if used, can be horizontal or vertical as recommended by the Manufacturer or shown on the drawings. Fan cowl and hand protection guards shall be fitted. Coolant temperature shall be controlled by one or more thermostats as determined by design of system. Radiator shall be sized for continuous performance at 110% rated load at worst operating ambient conditions with a 10 deg. C temperature differential. Radiator shall be non-ferrous metal, incorporating pressure valve, radiator cap and drain cock and with integral expansion tank. Direct acting modulating thermostatic diversion valve shall control engine cooling water temperature. Under normal operation, by-pass shall not be fully closed. Treated or fresh cooling water and anti-corrosion and anti-freeze additives shall be used as recommended by Manufacturer for Specific Conditions of Installation. Coordinate with the plumbing works for the provisions/piping needed for coolant drain.

K. Cooling Airflow: Obstructions in path of cooling air flow (openings, louvers, attenuators, grilles, mesh, ducts, bends etc.) shall not reduce air flow below that needed at full rated output. Fan and radiator characteristics shall be selected accordingly. Advise if additional booster fans are required and provide necessary control gear for automatic operation. Submit static pressure calculation vs. fan capacity to substantiate the Selection.

L. Cylinders shall have removable liners. Wet type liners shall have witness hole between liner sealing rings of each cylinder for early detection of coolant or oil leakage. Each cylinder shall have drilled and tapped hole and valve for connections of pressure indicator, unless other wise recommended by the manufacturer and approved by the Engineer.

M. Lubricating Oil System: Pressurized circulating type, using two engine-driven, gear type lubricating oil pumps with full flow filters and replaceable elements and lubricating oil heat exchanger. Filter system shall have spring loaded by-pass valve to permit oil circulation if filters become clogged. Audible and visual alarms shall cut-in when valve starts opening. Lubricating oil cooler shall be shell and tube heat exchanger with water from engine radiator as the cooling medium. Direct acting thermostatic diversion valve shall control oil temperature. Under normal operation by-pass shall not be fully closed. Coordinate with the plumbing works for the provisions/piping needed for proper and neat oil change.

N. Fuel system shall have injection pump and injectors that are easily removable and replaceable for servicing. Engine shall have integral, gear type, engine driven transfer pump to lift fuel against a head of 2.5 m and supply it through filters to injection pump at constant pressure. Fuel filter elements shall be easily replaceable.

O. Exhaust system shall be complete with flanged, bolted, black steel pipe sections, long sweep elbows, flexible steel expansion sections, clean-outs, silencer, wall thimbles and supporting steelwork. Silencer shall be independently supported. Indoor hot exhaust parts shall be insulated with mineral rock wool material, not less than 50 mm thick, retained by wire ties and cladded with sheet metal

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aluminum (22 - SWG) covers to protect insulation. Exhaust piping shall be fitted with rain cap, drain measures (condensate traps, drain plugs/valves, etc.) to avoid rain ingress and internal corrosion. Exhaust system shall be designed to reduce back-pressure to below maximum specified by the manufacturer, in relation to exhaust pipe length shown on the Drawings. Manufacturer's calculations for exhaust pipe sizing shall be submitted for approval including back pressure temperature and necessary measures to be applied against corrosion and to ensure efficient operation.

P. Electric Starting System: Engine starting shall be manual by push-button or automatic through control system at control panel. System shall consist of heavy-duty 24 V D.C. starter motor, heavy-duty battery and battery charger. Cranking motor and battery shall be rated for cranking the engine when cold and at lowest temperature recorded. Starting pinion shall automatically disengage when engine fires.

Q. Storage Battery: Lead-acid, sealed-in-plastic type, complete with battery rack and inter-cell connectors. Battery shall have sufficient capacity to provide minimum four cranking periods.

R. Battery Charger: 25% over-rated, solid state, full-wave rectifier type, adequate to fully recharge depleted battery in not more than 8 hours and to automatically control rate of charge (providing a high-charge rate to a depleted battery and reducing to a trickle-charge rate when battery is fully charged). Ammeter shall be provided to indicate charging rate, which shall be adjustable. Battery charger shall be mounted in control cubicle, unless otherwise approved.

S. Electronic Governor shall provide isochronous governing, (and paralleling and load sharing of generator sets in the case of paralleled generators). Governor shall have zero percent (isochronous) setting and adjustable droop from zero percent to 10% droop. System shall include power supply unit, magnetic speed pick-up, control module and actuator using fast response D.C. motor drive or equally approved alternative. Governor shall be designed for fast-response and high precision of speed (frequency) control, automatic paralleling and load sharing and shall include speed adjustment to +/-5% of normal, while running, and with remote control interface.

T. Governor over-speed trip shall automatically close fuel pump racks in event of engine over-speed. Device shall be separate and independent from governing mechanism.

U. Protective system shall comprise automatic engine shut- down and generator trip with visual and audible alarms in event of over-speed, low lubricating oil pressure, high cooling water temperature and over cranking.

V. Exhaust system shall be equipped with a soot filter to remove the Diesel particulate matter.

W. The soot filter shall be made of high grade 304 stainless steel and shall have high performance including the following:

Low pressure drop in the exhaust system.

High resistance to mechanical shock due to rough handling and engine vibration.

High resistance to thermal shock startup, shutdown and engine cycling.

120.040 GENERATOR (ALTERNATOR)

A. Type: Synchronous, low reactance, high efficiency, revolving field type, with brushless exciter and flexible coupling, sized to pick up effective load without exceeding transient and steady-state voltage deviation limits specified up to its full nominal rating and designed for the performance stipulated in the Specification. It shall be one bearing construction with bearings of the sleeve or sealed ball type.

B. Leads and Cables: Phase leads shall be brought out fully insulated to a terminal cable box of heavy gauge sheet steel, protection IP 44. Control and protection cables shall be brought out to a separate terminal box.

C. Maximum voltage difference between the three phases at 100%-balanced load shall not exceed 1%. With unbalanced load up to 30% on one phase at unity power factor and zero load on other phases, the line-to-neutral voltages shall not differ by more than 5%.

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D. Characteristics:

1. Number of Phases: 3 phases, 4-wires.
2. Rated Voltage, Frequency, and Net Rated Output: As shown on the Drawings
3. Rated power factor: 0.8.
4. Winding Connection: Re-connectable with ends brought out and fully insulated.
5. Maximum Unbalanced Load Current, (negative sequence component of current) with None of the Phase Currents Exceeding Rated Current: 8% of the rated current.
6. Overload: 10% nameplate rating for 1 hour every 12 hours
7. Rotor: Salient pole type, incorporating damping grid.
8. Excitation: Brushless, with rotating armature rectifiers and discharge resistors.
9. Voltage Regulator: Automatic, with readily accessible controls for voltage level.
10. Insulation: Class H for stator and class H for rotor & exciter, with class F temperature rise, unless otherwise indicated on the drawings.
11. Enclosure: Drip proof and screen protected (IP 21 to IEC 60529).
12. Cooling: Built-in centrifugal fans.
13. Maintained Short Circuit: 250% for 3 seconds.
14. Over-speed: 120% (minimum) for 2 minutes.

E. Voltage Regulation: Overall voltage deviation within normal speed variations shall be within limits specified from no-load to full-load, from hot to cold and with load power factor from 0.8 lagging to unity. Regulator shall automatically reduce voltage if load exceeds capacity of generator. Voltage build-up shall be positive and rapid even when full load is suddenly applied. Line-to-line voltage waveform deviation factor shall not exceed +/-5%. Total harmonic content shall not exceed 5% and that of one harmonic not to exceed 3%. Radio interference suppression shall be within the limits set by the Standards, grade (N).

F. Exciter: Armature shall be 3-phase, directly mounted to generator shaft and connected to generator field windings through six solid state, hermetically sealed, silicon rectifiers, accessible for maintenance or repair. Exciter shall have field suppression system to eliminate any source of diode failure resulting from high inductive loads and surges. Exciter field windings shall be stationary. Exciter-regulator combination shall maintain output voltage within limits specified for any load up to 110% generator rating and under any sudden load changes specified.

G. Voltage Regulator: Solid state, volts/Hz type, utilizing silicon semi-conductor devices in control and power stages, with built-in Electro-magnetic interference suppression and designed for single or parallel operation. Manual adjustment to +/-5% of regulated voltage level shall be possible by a potentiometer at control panel. All components shall be sealed, moisture and heat resistant, with a suitable environmentally protected enclosure. Voltage regulator shall automatically reduce voltage if load exceeds capacity of generator and shall sustain a 3-phase short- circuit current at the generator terminals for the period for which the short-circuit protection operates and at least for 3 seconds. Voltage regulator power shall be supported by generator voltage and current to maintain excitation field power.

H. Two-position switch shall be provided for selection of manual or automatic mode of regulated voltage control.

I. Sets Operating In Parallel: Cross-current compensation and necessary paralleling modules shall be provided to effect sharing of active and reactive loads equally between generators.

120.050 INSTRUMENTATION, PROTECTION AND CONTROL EQUIPMENT

A. Generating Set Instruments, Protection And Controls: Control relays, sensing equipment, switchgear protective relays and devices and start, stop and shutdown controls shall be provided as necessary for operation specified. Generating set, instruments, protection and controls shall be mounted preferably in one control cubicle.

B. Generator controls, metering, monitoring and protection shall be carried out via modular solid state, microprocessor based units, with digital display facility

C. Instruments and controls for a non-paralleled set shall include at least the following:

1. Line and phase voltage metering on the 3 phases.

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2. Current metering on the 3 phases.
3. Frequency meter.
4. Off/test/manual/auto duty switch.
5. Manual-start and stop push buttons.
6. Kilowatt-hour meter.
7. Power factor meter.
8. Service-hour running counter.
9. Plant exerciser.
10. Potentiometer for voltage level control.
11. Speed raise/lower device.
12. Cool-down time setting controls.
13. Over cranking monitoring and alarm
14. Illuminated indicator panel with LEDs at least for low oil pressure, high water temperature, over-speed, fail-to-start, generator overload, reverse-power, generator on load, battery low charge state
15. Lamp test push-button.
16. Indicating gauge and low level fuel alarm.
17. Battery charger, on/off switch, pilot lights.
18. D.C. ammeter.
19. Alarm sounder and reset controls.
20. Anti-condensation heater.

D. Protective gear shall ensure orderly engine stop or shutdown with reset relays, as required for safety and operational reliability, and shall include the following:

1. Output air circuit breaker (ACB) with solid state trip unit, in accordance with Division Y Section "Switchboards", (electrically operated and electrically tripped by shunt release) for over-current and external earth fault protection.
2. Over-voltage protection with voltage and time lag adjustment.
3. Loss-of-field protection.
4. Negative phase sequence protection.
5. Restricted earth-fault protection, with current adjustable settings between 0 and 20% of rated current, and time adjustable settings 0 to 3 seconds.
6. Reverse power relay (for sets operating in parallel).

E. Control and Protective Gear Cubicles: Generator set mounted instrument and/or control cubicles shall be resiliently mounted, preventing transmission of vibration to the components. Separately mounted instrument and control cubicles shall be self-supporting, floor mounted and free- standing. Cubicles shall be sheet steel construction, ventilated indoor type, vermin and dust-proof, (IP 42 to IEC 60529), with lockable hinged doors and instrument panels, separate compartments for control devices, protective relays, circuit breaker(s) and neutral earthing device. Inner and outer surfaces of steel enclosures shall be cleaned, phosphatized, primed with heavy-duty rust inhibiting primer and finished with two coats of enamel. Wiring shall be 600/1000 V, modularly arranged, with connections made at front terminal blocks with no live conductors exposed. Wires shall have approved numbered ferrules at each terminal. Printed circuit plug-in boards, where applicable, shall be of industry standards, accessible and withdrawable, mounted in standard racks.

F. Load Shedding: An automatic microprocessor based load shedding system shall be provided for load connection / disconnection according to load priorities and generator power availability as described on the drawings.

G. Step Loading : An automatic step loading system shall be provided for sequential application of emergency loads with an adjustable (0- 30 sec) time delay between each two steps as described on the drawings. The system shall comprise all necessary control equipment including under over/ voltage sensing relays, time delay relays, interface devices and wiring with respective circuit breakers.

H. Parallel operation of generator sets shall be achieved through generators' control panel in decentralized topology. Contractor shall provide the following

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1. Generator control panel with synchronizing functionality, , automatic switching and automatic active and reactive load-sharing modules, as required for paralleling as specified here below, together with sequential starting system based on demand load sensing, to allow automatic starting and transfer of load from one set to another without break in supply.
2. One neutral earthing switch per set, interlocked in cascade, such that switch of the first generator to start and be connected to the bus, is closed. The switches shall be make-before-break-type so that the neutral switch never floats in case the generator with the neutral closed fails or is shut off the system.

I. For Short-Break Set: Provide complete control package with necessary relays, contactors, clutch control system, control rectifier and D.C. supply, automatic load application system, load transfer switches and load sensing components for activating the sequences of operation described.

J. For no-break set provide programmable controller, with fault-indicating and logic cards, automatic starting system, coupling controls and synchronizing systems, main contactor and other functional contactors, frequency and voltage sensing devices, independent regulated and controlled D.C. power supply equipment for control of induction coupler and Electro-magnetic clutch etc. to activate the sequences of operation described.

K. Relays: electronic, microprocessor based front settable / programmable, sealed type, with dust-tight enclosures, removable covers, test terminal blocks and plugs for testing relay without removal from case. Removal from casing shall automatically short-circuit respective current transformer secondary windings.

L. Instruments shall be housed in enameled metal cases for switchboard flush installation and shall be grounded in accordance with the approved standards.

M. Current Transformers: Class 2 for measuring and protection. Refer to switchgear sections for particulars.

N. Voltage Transformers: Single phase, dry type, 0.5 accuracy class. Refer to switchgear sections for particulars.

O. KWH Meter: digital (part of microprocessor unit) for unbalanced 3-phase, 4- wire loads.

120.060 SYNCHRONIZING AND CONTROL PANEL

A. Synchronization shall be performed through generator set mounted control panels. System shall be of the decentralized, automatic random access system type with automatic load pickup, load sharing, and load demand paralleling and shall be fully featured for unattended operation and expansion for future load and integration with generator addition(s).

B. Control panels shall accommodate metering / monitoring, control and protection units / instruments, synchronizing equipment and all necessary associated components (as described below) for the parallel generating sets. Control panels shall be micro-processor based of the fully computerized type. Control panels shall be equipped with the necessary interfaces for connection to and control of the generator circuit breakers and outgoing feeder circuit breakers of the emergency distribution board.

C. Synchronizing switch panel shall include:

1. 3-bus AC voltmeter, 90 mm, 90 att-. volt scale.
2. 2 synchronizing lamps.
    a) One frequency meter for station bus and generator units, dial type, 45-55 Hz scale.
3. Fail circuitry including:

a)	Overload/Load Shed:	Alarm and immediate shed only.
b)	Over Voltage:	Alarm only.
c)	Under Voltage:	Alarm only.
d)	Over/Under Frequency:	Alarm only.
e)	Station Battery Failure:	Alarm only.

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4. Master control delay with heavy-duty control relays including, synchronizer, etc. mounted on a plate to facilitate removal and testing. All failure and synchronizing relays shall be provided with glass enclosures and plug-in bases to facilitate removal and testing.
5. Sequence Of Operation: For two or more generator sets to be paralleled via the synchronizing board, the sequence of operation shall be as follows:

    a) Auto-Mode:

        1) On receipt of a start signal indicating the loss of power, all generator sets shall automatically and independently start, accelerate to rated frequency and build up to rated voltage. The first unit to reach the preset level closes to the bus with the other units disabled in doing so. The first priority load is then switched to the emergency system bus. The priority controls prevents the overloading of the system bus by inhibiting the operation of the lower priority load switching until additional generator-sets are closed to the bus.
        2) The control of the remaining generator-sets is reverted to the synchronizing system for each paralleling operation in sequence. Each generator-set then synchronized with the system bus and closed will assume its proportional share of the load. Also, as each generator-set close to the bus lower priority loads will be switched on automatically and shared by the system proportionally.
        3) If a generator fails to start, or the bus overloads or a generator fails, the corresponding breaker shall open (or remain open), the alarm will sound and the lowest priority loads shall be shedded.
        4) The microprocessor of the system shall continually monitor the total load on the bus, and should the system be able to carry the entire load safely with fewer generators, the controller will shut off some of the generator units.
        5) Upon the return of normal power and after an adjustable preset time all the generator breakers shall open and the generator-sets shall run unloaded for a cool down period, then shut off and be ready for another automatic operation.

D. Each generator paralleling control panel shall include the following functions:

1. Line and phase voltage metering on the 3 phases, current metering on the 3 phases, frequency metering and kilo watt metering, 2% accuracy.
2. Running time metering.
3. Synchronization and load sharing functionalities.
4. Programmable controller to manage the load demand, priority control and load shedding.
5. Synchronization check.
6. Monitoring of bus voltage, current and frequency.
7. Alarm and status indication for:

a)	Generator Running:	Status indication.
b)	Automatic Mode:	Status indication.
c)	Demand Mode Standby:	Status indication.
d)	Cool-down Mode:	Status indication.
e)	Fail To Synchronize:	Trouble alarm indication.
f)	System Test:	Status indication
g)	Utility Power Failure:	Status indication
h)	High Engine Temperature:	Alarm - shutdown.
i)	Low Oil Pressure:	Alarm - shutdown.
j)	Low Engine Temperature:	Trouble alarm indication.
k)	Low Day-tank Level:	Trouble alarm indication.
l)	Not In Auto:	Trouble alarm indication.
m)	Generator Over-Current:	Alarm - shutdown.
n)	Loss Of Field:	Alarm - shutdown.
o)	Reverse Power:	Alarm - shutdown.
p)	High Temperature Shutdown:	Alarm - shutdown.
q)	Low Oil Pressure Shutdown:	Alarm - shutdown.
r)	Over-crank:	Alarm - shutdown.
s)	Over-voltage:	Alarm - shutdown.

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t) Over-speed: Alarm - shutdown.
u) Control Locked Out: Alarm - shutdown.
v) Low Coolant Level: Alarm - shutdown.
w) Low Fuel Main Tank: Trouble indication

8. Audible and Visual alarms.
9. Alarm silence push-button to shutoff sound but maintain visual on.
10. Auto-Off-Manual selector switch.
11. Control reset push-button.
12. Breaker control push-buttons/ switch for circuit breaker on/off switching.
13. Locking voltage and frequency adjustment potentiometers.
14. Complete engine control including DC gauges.
15. Reverse power relay test switch.
16. Ground fault alarm to generator main breaker.
17. Automatic Control Components:

a) Electronic governor control and load sharing module for isochronous load sharing and control of the generator set's electronic governors.
b) First start sensor for monitoring the voltage and frequency of the generator-set as it is starting.
c) Electronic reverse power relay.
d) Synchronizer to adjust phase angle and frequency before paralleling.
e) Pulse alarm system to sound alarm at first fault and each additional fault.
f) Permissive paralleling relays to prevent out of phase paralleling in automatic and manual modes.
g) DC Voltage sensor with time delay monitor for starting battery system.
h) System starting controls.
i) Bus under-relay.
j) Master first start sensor.
k) Time delay start relay.

120.070 FUEL STORAGE AND TRANSFER

A. Day-tank Construction: Closed cylindrical steel, inclined at least 3 degrees from horizontal and fitted with drain plug, inlet and outlet pipe connectors and breather pipe or as shown on drawing (Sub-base fuel tank).

B. Day-tank breather pipe shall have replaceable paper air filter or breather caps with air filters.

C. Day-tank instruments shall include float switch, solenoid valve and dial-type level indicator to give alarm on over-fill and low-level.

D. Pipes and valves: between day tank and generator (within Electrical scope) shall be as per Mechanical specifications.

E. Day-tank Filling Pumps: Electrically operated, automatically started and stopped, duplex pumps and standby manual pump, installed on piping system between storage tank and one or more day-tanks for fuel transfer. Motor shall be totally enclosed, fan-cooled, squirrel-cage induction type, with integrally coupled pump-rotor contained on one base. Pump shall be self-priming type against the specific head shown on the Drawings. Priming plug, sealed and protected bearings and combination starter with thermal overload protection and circuit breaker for short-circuit protection shall be provided. Operation shall be interlocked with float switches in day-tank. All necessary check valves, by- pass valves, float valves and maintenance valves on piping system shall be provided as shown on the Drawings.

F. Day-tank Connections: Female threaded, black forged steel pipe couplings, fitted through holes in top of tank and welded all around inside and outside. Connections, except vent connection, shall extend inside tank to within 150 mm of bottom and shall be seamless black steel pipes of same size as connection and braced to tank walls. Vent connection shall not extend inside tank more than 20 mm. A manual valve shall be provided on the fuel supply line to the genset.

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G. Fuel Lines: Heavy gauge, black seamless steel, to ISO/65 or equal, treated internally with corrosion resistant paint and with joints sealed with PTEE tape. Plumber's twine or gasket sealing compound shall not be used. Changes in direction and branching and jointing shall be with regular pipefitting. Field fabricated and bent fittings shall not be used.

H. Fuel Lines: Fuel feed line to day-tank shall have by- pass with stopcock. Size of fuel return line from day-tank to main fuel tank shall be to manufacturer's recommendations.

I. Valves Generally: 827.4 kPa (steam working pressure rating and 1380 kPa cold water non-shock pressure rating and type that can be repacked under pressure.

J. Pipe Hangers and Supports: Galvanized steel.

120.080 MISCELLANEOUS REQUIREMENTS

A. Manually Operated Overhead Hoist: Chain operated, self aligning, low headroom type, comprising trolley with gear mechanism combined into a compact unit, designed to run on lower flanges of I-beam runway. Hoist shall have shock resistant suspension, positive action Western type local brake; lifetime lubricated sealed bearings and load safety hook. Trolley shall have four alloy cast iron wheels. Safety factor shall be minimum of 5. Capacity of hoist shall be as indicated on the Drawings, and shall be tested to 1.5 times rated capacity.

B. Power And Control Cables: Comply with Division Y Section "Low Voltage Electrical Power Conductors and Cables", and Section " Control/Signal Transmission Media" of the Specification and as shown on the Drawings.

C. Earthing Equipment: Comply with Division Y Section "Earthing And Bonding" of the Specification.

PART 1 REFERENCES

100.000 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and Division A Specification Sections, apply to this Section.

110.000 RELATED SECTIONS

A. Division S Section "Fuel Oil Storage and Distribution" for interior fuel piping and fuel storage tank.

B. Division Y Section "Pipelines and Pipework" for coolant piping external to engine generator.

C. Division Y Section "Air Ductlines and Ancillaries" for combustion air and radiator fan discharge connections.

D. Division V Section "Basic Electrical Materials and Methods"

E. Division Y Section "Transfer Switches" for transfer switches, including sensors and relays to initiate automatic-starting and -stopping signals for engine generator sets.

F. Division Y Section "Low Voltage Electrical Power Conductors and Cables"

G. Division Y section " Earthing And Bonding "

PART 2 PRODUCTS AND WORKMANSHIP

200.000 MATERIALS

200.010 MANUFACTURERS

A. Approved Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

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1. Caterpillar
2. Cummins (Onan)
3. Deutz
4. Kohler
5. M.T.U.
6. MAN-B&W
7. Volvo
8. Wartsila
9. Perkins
10. Pet bow

200.020 PRODUCTS

A. Products: Subject to compliance with requirements, provide one of the products indicated for each designation as shown on plans.

210.000 QUALITY MANAGEMENT

210.010 QUALITY ASSURANCE

A. Local Representative: Provide evidence that proposed equipment manufacturer has a locally established and authorized organization which can be called upon for professional advice and maintenance as may be required, and which can immediately supply spare parts to support day to day and emergency maintenance requirements. Failure to satisfy Engineer may disqualify a manufacturer.

B. MAINTENANCE CONTRACT: obtain an undertaking by the equipment manufacturer and his authorized local representative to provide an annual maintenance contract, available after substantial completion of the work, covering routine service and emergency service by trained employees, and to ensure supply of necessary standard spare parts.

210.020 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle generator set and system components as per Manufacturer's instructions.

210.030 WARRANTY

A. Manufacturer's Warranty: Submit a written warranty signed by the manufacturer agreeing to repair, restore or replace any defective equipment specified in this section during the specified warranty period

1. Warranty Period: 1 year from date of Substantial Completion.

210.040 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance service by skilled, competent employees of the generator Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper generator operation at rated speed and capacity. Use parts and supplies as used in the manufacture and installation of original equipment.

1. Include 24-hour-per-day, 7-day-per-week emergency callback service.

a) Response Time: 1 hour or less.

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210.050 SPARE PARTS AND EXTRA MATERIAL

A. Spare Parts: Provide manufacturer's recommended spare parts for 1000 hours operation of the plant. Provide list of manufacturer's spare parts for 2000 hours operation together with current prices. Pack with protective covering for storage and identify with labels describing contents.

B. Tools and Instruments: Provide tools and instruments required for normal routine inspection, testing, operation and general maintenance, as recommended by the manufacturer.

220.000 SUBMITTALS

A. Product Data: Submit full technical data of equipment for approval including, but not limited to, the following:

1. General description and characteristics of engine- generating sets, standards with which components comply, site rating and overload capability, overall efficiency, and fuel and lubricant consumption at 100%, 75%, 50% and 25% of rated load.
2. Description and operating criteria of engine; type, model, manufacturer, fuel and lubricating oil types and specific consumption, starting conditions and starting periods from cold to full-load pick-up, governor and response characteristics due to sudden load changes, super-charger, fuel injection system, cooling system and radiator, air filters, fuel filters, oil filters and pumps.
3. Description and operating criteria of generator, exciter and voltage regulator, with loading response and short-circuit characteristics, insulation, cooling and accessories.
4. Dimensioned outline plan and elevation drawings of engine generator set and other components specified, weights and forces, mounting methods, vibration protection etc.
5. Battery type, make, charge/discharge characteristics, capacity and constructional features.
6. Battery charger, method of charging, equalizing and trickle charging.
7. Daily fuel tanks, pipes and accessories; materials and construction.
8. Exhaust system and silencers; materials and construction.
9. Control instruments, protection, alarms, cut-outs, indicating lamps, indicating instruments and all other devices or components.
10. Time-current characteristic curves for generator protective device.
11. Synchronization system where specified for two or more sets are in parallel, including technical data, instruments, governor and voltage regulation, with characteristic curves etc.
12. Calculation of noise levels in dBA at typical points within engine room and at various locations inside and outside.
13. Calculation of static pressure on radiator fan including indication of Manufacturer’s required C.F.M. and fan static pressure.

B. Shop and Construction Drawings: Submit drawings for approval including, but not limited to, the following:

1. Certified manufacturers' dimensional drawings, templates and installation instructions for equipment and accessories, showing weights and distribution of forces, location and size of cabling (power and control), piping connections to equipment, and other pertinent data.
2. Plans and elevations of all equipment.
3. Separate unit wiring diagrams, schematics and interconnecting wiring diagrams.
4. Constructional details of daily service fuel tank, including outline drawings showing piping arrangements, connections and dimensions.
5. Complete execution drawings of associated auxiliaries.
6. Overall Single Line Diagram of the plant, indicating ratings of different equipment and metering & protection devices.

C. Point-wise compliance statement to the specifications, duly signed by the manufacturer / manufacturer’s authorized representative and the contractor.

D. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

E. Routine Tests and Factory Test Reports: Fully assembled plant or equipment shall be tested at the factory, before shipping. Complete performance tests shall be carried out under site simulated conditions, in accordance with the Standards and as described in the Specification, showing evidence of compliance with specified requirements.

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F. Field Test and Observation Reports: Indicate and interpret test results and inspection records relative to compliance with performance requirements.

G. Certified Summary of Performance Tests: Demonstrate compliance with specified requirement to meet performance criteria for sensitive loads.

H. Sound measurement test report.

I. Field test report of tests specified in Part 3.

J. Maintenance Data: For each packaged engine generator and accessories to include in maintenance manuals specified in Division 1. Include the following:

1. List of tools and replacement items recommended to be stored at the Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
2. Detail operating instructions for both normal and abnormal conditions.

230.000 EXECUTION

230.010 EXAMINATION

A. Examine areas, equipment foundations, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Examine roughing-in of cooling-system piping systems and electrical connections. Verify actual locations of connections before packaged engine generator installation.

230.020 CONCRETE BASES

A. Install concrete bases of dimensions indicated or otherwise required for packaged engine generators. Refer to Division E Section " Accessories Cast Into In Situ Concrete " and Division V Section "Basic Electrical Materials and Methods."

230.030 INSTALLATION

A. Equipment Bases: Ensure that concrete bases and foundations provided for installation of equipment are constructed in accordance with approved shop and construction drawings and manufacturers' equipment drawings and that holes for fixing bolts and provisions for passage of cables etc. are provided as required.

B. Install packaged engine generator to provide access for periodic maintenance, including removal of drivers and accessories.

C. Built-In Items: Ensure that equipment supports, fixings and the like, and sleeves for passage of feeders and cables which shall be built into concrete foundations, bases or building structure are provided as and when required and that they are properly installed.

D. Tools: Use only tools recommended by equipment manufacturers for installations, particularly in making connections and adjustments.

E. Supervision: Carry out equipment installation under the direct supervision of a qualified technician, licensed by and trained at the factory. Final adjustments and putting into satisfactory operation shall be made by a specialist delegated by the factory.

F. Generating Set: Install to maintain alignment and minimize engine and generator stresses. Protect instrumentation and control equipment including engine mounted instruments from machine vibration. Mountings and method of mounting shall be as recommended by the manufacturer and approved by Engineer.

G. Engine exhaust piping shall be slightly sloped away from engine to avoid condensation returning to engine and shall have drain plugs or clean-out at lower end as required.

H. Engine Hot-Air Exhaust Duct: Install approved canvas duct with metal frames between radiator and louvered opening in wall for radiator exhaust air.

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I. Tank Vent Pipe: Extend to nearest outside wall of building and carry up to at least 2 m above ground level with end at least 1 m away from any building opening. Slope vent pipe back to tank without traps and support securely. Provide replaceable dust filter and gooseneck bend or approved weatherproof vent cap at top of pipe.

J. Pipe Hangers And Supports: Fasten securely to building structure with approved masonry expansion bolts, minimum 20 mm diameter and install in accordance with manufacturers' instructions.

K. Earthing: Install earthing system in accordance with Division Y Section " Earthing And Bonding " of the Specification.

230.040 CONNECTIONS

A. Piping installation requirements are specified in Division 22 and 23 Sections. Drawings indicate general arrangement of piping and specialties. The following are specific connection requirements:

1. Install piping adjacent to packaged engine generator to allow service and maintenance.
2. Connect water supply to cooling system.
3. Connect cooling-system water supply and drain piping to diesel engine heat exchangers. Install flexible connectors at connections to engine generator and remote radiator.
4. Connect exhaust-system piping to diesel engines.

B. Electrical wiring and connections are specified in Division V Sections.

C. Ground equipment.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in applicable Standards.

230.050 IDENTIFICATION

A. Identify system components according to Division V Section "Basic Electrical Materials and Methods."

230.060 INSPECTION AND TESTS ON SITE

A. Supervised Adjusting and Pretesting: under supervision of factory-authorized service representative, pretest all system functions, operations, and protective features. Provide all instruments and equipment required for tests. Adjust to ensure operation is according to Specifications. Load system using a variable resistive and reactive load bank to be provided during testing only simulating kW, and power factor of loads for which unit is rated.

B. Tests: provide the services of a qualified independent testing agency to perform the tests listed below according to manufacturer's recommendations upon completion of installation of system. Use instruments bearing records of calibration within the last 12 months, traceable to approved standards, and adequate for making positive observation of test results. Include the following tests:

1. Insulation Tests: test generator windings using 500 V d.c. for units rated up to 250 volts and 1000 V d.c. for units rated between 250 and 600 volts. Verify minimum insulation resistance is 25 megaohms for units up to 250 volts, and 100 megaohms for units 251 to 600 volts. Verify by dielectric absorption test that polarization index levels are according to manufacturer's industry standards approved.
2. Battery Tests: measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery. Verify acceptance of charge for each element of battery after discharge. Verify measurements are within manufacturer's specifications.
3. Battery Charger Tests: verify specified rates of charge for both equalizing and float-charging conditions.
4. System Integrity Tests: methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.

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5. Simulation of malfunctions to verify proper operation of local and remote protective, alarm, and monitoring devices.
6. Load Test: use variable load bank capable of simulating kVA, kW, and power factor of load for which unit is rated. Run unit at 25, 50, and 75 percent of rated capacity for 30 minutes each, and at 100 percent for 3 hours immediately followed (in case of prime generators) by 10 % overload test for 30 minutes. Make the 100-percent load run at 80 percent power factor. Record voltage, frequency, load current, battery-charging current, power output, oil pressure, and coolant temperature periodically during the test.
7. Vibration Baseline Test: measure amplitude for nominal frequency and for frequencies 5, 10, 15, and 20 percent above and below nominal at each main bearing cap. Vibration levels not exceeding those specified in NEMA MG1, "Motors and Generators," are acceptable.
8. Exhaust System Back-Pressure Test: use a manometer with a scale exceeding 40 inches of water. Connect to the exhaust line close to the engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's published allowable limits for the engine.
9. Exhaust Emissions Test: conform to applicable government test criteria.
10. Voltage and Frequency Transient Stability Tests: use recording oscilloscope to measure voltage and frequency transients for 50-percent and 100-percent step-load increases and decreases and verify that performance is as specified.
11. Harmonic Content Tests: measure harmonic content of input and output current under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.
12. Efficiency Tests: perform at 50 percent, 75 percent, and 100 percent of rated load.

C. Retest: correct deficiencies identified by tests and observations and retest until specified requirements are met.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Test instruments shall have been calibrated within the last 12 months, traceable to applicable standards, and adequate for making positive observation of test results. Make calibration records available for examination on request.

230.070 COMMISSIONING

A. Battery Equalization: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

230.080 CLEANING

A. On completion of installation, inspect system components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

230.090 DEMONSTRATION

A. Train Employer's maintenance personnel to adjust, operate, and maintain the system installation. Refer to Division A Section "Demonstration and Training and Closeout Procedures."

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V11B - MEDIUM-VOLTAGE TRANSFORMERS

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. This Section includes distribution step down transformers with medium-voltage and/or low voltage primaries and secondaries as specified.

B. Related Sections include the following:

1. Division V Section "Basic Electrical Materials and Methods".
2. Division Y Section "Enclosed Bus Assemblies" for busway connections between transformers and secondary distribution equipment.
3. Division Y Section "Medium-Voltage Cables" for cable terminations at transformers.
4. Division W Section "Central Control / Building Management ".

C. Necessary interfaces for connection to BMS system, including interface elements such as relays, transducers, etc. as specified and /or shown on the Drawings.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Standards: Equipment and component parts shall comply with the following Standards:

1. Common clauses for HV switchgear and control gear standards: IEC 62271-1.
2. Power transformers: IEC 60076.
3. Insulated bushings for alternating voltages above 1000 V: IEC 60137.
4. Material thermal class insulation: IEC 60085.
5. For transformer characteristics: BS EN 50708-2-1 for dry type transformers.
6. Neutral Earthing Resistor: IEEE standard C57.32.

120.000 SYSTEM DESCRIPTION

120.010 DRY TYPE CAST RESIN POWER TRANSFORMER

A. Type:

1. 3-phase, indoor type.
2. Step down, two winding.
3. MV windings shall be cast epoxy resin under vacuum.
4. LV windings shall be insulated with insulating foil impregnated / pre-impregnated with epoxy resin and heat cured afterwards.
5. Insulation for both LV and MV windings shall be class F as a minimum, rated for continuous operation under worst site ambient conditions at full load, and complying with IEC 60076-11.
6. Windings temperature rise shall not exceed 80 deg. C.
7. Transformer core shall be constructed from high grade, non-aging “Cold Rolled Grain Oriented” silicon steel laminations with suitable grade to fulfill the losses and noise levels specified below.

B. Transformers shall be suitable for continuous operation at cooling air temperature of 50/40/30 deg. C at any time, monthly average of hottest month and yearly average respectively.

C. Transformer no load and load losses shall not exceed BS EN 50708-2-1 values for class Tier 2.

D. Transformer’s emergency overloading capability shall comply with IEC 60076-12.

E. Noise Level: A weighted sound power (LWA) level calculated in accordance with IEC 60076-10 (with fans off) shall not exceed BS EN 50708-2-1 values for the specified classes in paragraph 120.010 C above.

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F. Noise level for transformers with fans: the sound power level with all fans in operation shall not exceed 6 dB additional to the specified limits.

G. Insulation and Encapsulation: Humidity resistant, explosion and fire-resistant, self-extinguishing, tropicalized, giving non-toxic gases in the event of fire. To fulfill environmental, climate and fire classes of E2, C2 and F1 respectively to IEC 60076-11 / BS EN 50708-2-1.

H. Windings: Medium voltage winding shall be Copper strip conductor, and low voltage winding shall be Copper conductor foil, unless otherwise approved.

I. Winding current densities at rated normal and short circuit conditions shall be submitted for approval. Normal densities shall not exceed 1.8 A/mm2 for Copper winding, unless otherwise submitted by manufacturer and approved by engineer.

J. Tapping shall be provided on MV side by means of re-connectable links (off-circuit), giving +/- 2.5% and +/-5% tapping on transformers for each primary voltage rating.

K. Rubber sound isolation pads shall be provided between core and coil assemblies, and between base and housing.

L. Mounting and Handling: Transformer base and structure shall have lifting hooks or lugs, towing and lashing eyes or lugs and provision for roller wheels.

M. Terminals: Arranged as described in paragraph 120.010 Q hereof and/or as shown on the Drawings, and shall be compatible for copper or aluminum cable termination.

N. Enclosure's earthing bolt(s) or copper pad(s) shall be provided on main frame of transformer for earthing of transformer's housing and core.

O. LV star neutral point shall be connected to a separate earthing terminal fixed to but insulated from the enclosure and shall be labeled with the same.

P. Housing: Sheet steel construction, IP 31 with provision of fans for indoor installation.

Q. Characteristics:

1. Rated Power (net site rating): as shown on drawings.
2. Winding Connections: Dyn 5 with neutral fully insulated and brought out.
3. Frequency: 50 Hz.
4. Highest Voltage Um (rms):

   a) MV Side 24 kV.
   b) LV Side 1.1 kV.

5. Rated Voltage (no load):

   a) MV Side 15 kV.
   b) LV Side 420 V.

6. Impedance Voltage at Rated Current: 6 %.
7. Tap-Changer Positions: +/- 2.5% and +/- 5% on primary.
8. Rated Power Frequency Withstand-Voltage: 50 kV.
9. Rated Lightning Impulse Withstand-Voltage: 125 kV.
10. Short-Circuit Apparent Power of the System at Location: 500 MVA for 15 kV systems and 1000 MVA for 30 kV systems as a minimum.
11. Duration of Short-Circuit-Withstand: 2 seconds.
12. Terminal Connection System:

    1) MV Side: open bolted terminals / bushings with cable sealing ends (epoxy joints). Cable entry shall be from bottom.
    2) LV Side: open bolted terminals / bushings with cable sealing ends (epoxy joints) or as shown on drawings. Cable entry shall be from bottom.

R. Where single core cables are used, top / bottom cable entry plates shall be made of bakelite or Aluminum with adequate thickness and rigidity to support cables.

S. Accessories shall include the following:

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1. Digital protective unit for transformer monitoring and protection against winding temperature and contacts for fan controller operation with display for indication of winding temperature values and alarm / trip status, 2 N.O. contacts for winding temperature alarm and trip the upstream medium voltage switchgear circuit breaker flag relays, with data link interface port for connection to BMS, along with necessary winding temperature sensors (at least one 3-wire PT100 / RTD 200 or equivalent per phase) and interface with fan control and protection system.
2. Fans and fans digital control unit for extra rating of transformer. Controller shall have input dry contacts interface for remote control enable and output alarm/fault relay. Controller shall comply with IEC 61000-6-2 for EMC immunity and with IEC 61000-6-4 for EMC emission. Controller shall be similar to VRT200 or approved equal. Supplier shall coordinate with contractor for necessary power supply for fans and controller.
3. Four re-orientable roller rim wheels and attachment accessories.

T. Surge arresters: Provide surge arresters as specified under Division V Section "Medium Voltage Switchgear", on MV side of transformers, unless surge arrestors are located on the switchgear in the Drawings or it is agreed with the Engineer to provide the arresters on the outgoing MV circuit breaker cubicle of transformer for the cases where the distance between medium voltage switchgear and transformer is not exceeding 15m. The contractor is responsible for the coordination between the medium voltage switchgear and transformer suppliers.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and Division 01 Specification Sections, apply to this Section.

PART 3 PRODUCTS AND WORKMANSHIP

300.000 MATERIALS

300.010 MANUFACTURERS

A. Approved Manufacturers of Distribution Transformers: Subject to compliance with requirements, provide products by one of the following or approved equal:

1. A.B.B.
2. Schneider Electric / France Transfo
3. Schneider Electric / Areva
4. Schneider Electric / Square D.
5. G.E.
6. Eaton / Cutler Hammer Corp.
7. SGB
8. Pauwels/Crompton Greaves Ltd.
9. Siemens

B. Locally assembled dry type transformers by one of the above approved manufacturers are acceptable subject to compliance with design requirements and adequacy of reference list and quality control of the local factory.

300.020 PRODUCTS

A. Products: Subject to compliance with requirements, provide one of the products indicated for each designation as shown on plans.

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310.000 QUALITY MANAGEMENT

310.010 QUALITY ASSURANCE

A. Manufacturer Qualifications: Engage a firm experienced in manufacturing transformers similar to those indicated for this Project and with a record of successful in-service performance.

310.020 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle transformers as per Manufacturer's instructions.

310.030 COORDINATION

A. Coordinate layout and installation of transformers with other construction.

B. Coordinate size and location of concrete or mounting bases. Concrete, reinforcement, and formwork requirements are specified in Division E Section " Accessories Cast Into In Situ Concrete."

310.040 WARRANTY

A. Manufacturer's Warranty: Submit a written warranty signed by the manufacturer agreeing to repair, restore or replace any defective equipment specified in this section during the specified warranty period

1. Warranty Period: 1 year from date of substantial completion.

310.050 FACTORY ACCEPTANCE TEST

A. Factory testing units for one unit of each rating of the dry type transformers to be supplied shall be witnessed by the Engineer for locally assembled transformers. Selection of transformers for witness test shall be randomly carried out by the Engineer and shall cover all ratings to be delivered. Witness test shall include complete routine and function testing in addition to the special tests specified above. Test procedure and program shall be submitted for approval prior to test conduction, by at least 14 days.

310.060 SPARE PARTS AND EXTRA MATERIAL

A. Spare parts: provide spare parts as recommended by the manufacturer including but not limited to the items below, for one year maintenance, as expected under local conditions, and to allow for emergency replacement due to accidental breakage or failure. Spare parts shall include but not limited to the following:

1. Spare parts for dry type transformers with quantity greater than two shall include but not limited to fan, fan controller and temperature monitoring unit with a quantity of two percent of total number of transformers, with minimum one unit each.

B. Tools and Instruments: provide tools instruments required for normal routine inspection, testing, operation and maintenance as recommended by the manufacturer.

C. Provide complete price list of spare parts adequate for five years operation as expected under local conditions.

320.000 SUBMITTALS

A. Product Data: Include full technical data on features, components, ratings, and performance for each type of transformer specified. Include core material, grade, lamination thickness, flux density, winding material, and current density. Additionally, include dimensioned plans, sections, and elevation views. Show minimum clearances and installed devices and features. Submit Manufacturers' catalogues.

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B. Wiring Diagrams: Detail wiring and identify terminals for tap changing and connecting field-installed wiring.

C. Point-wise compliance statement to the specifications, duly signed by the manufacturer / manufacturer's authorized representative and the contractor.

D. Product Certificates: Signed by manufacturers of transformers certifying that the products furnished comply with requirements.

E. Type Test Certificates: Submit to verify compliance of main equipment with the relevant IEC Standards.

F. Routine Tests: Each transformer unit shall undergo routine tests at the manufacturer's works in accordance with the relevant standards. Submit routine test reports, prior to shipping equipment, indicating ambient test conditions and guaranteed rating of equipment under site conditions.

G. Special / Type Tests: Factory special and type tests shall include noise level, temperature rise, impulse withstand on one transformer of each rating to be delivered. In addition, dissipation factor test (tan-delta) shall be performed for oil type transformers.

H. Shop and Construction Drawings: Submit drawings for approval including, but not limited to, the following:

1. Plans and elevations, with dimensions and weights.
2. Arrangement of equipment and general layouts.
3. One-line diagram of power system.
4. Schematic diagram indicating the secondary wiring of transformer mechanical protection and the control circuit of cooling fans (if any).
5. General arrangement and drive mechanism details for off-circuit tap changer.
6. Foundation details, grouting holes and installation details.

I. Sound-Level Test Reports: Certified copies of manufacturer's sound-level tests applicable to equipment for this Project.

J. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

K. Maintenance Data: For transformers to include in the maintenance manuals specified in Division 01.

330.000 EXECUTION

330.010 INSTALLATION

A. Locations and Layout: Exact locations and physical layout of equipment and components may be varied as required to suit manufacturer's design and as approved, provided the required functions and operations are accomplished; follow the identification of the units indicated on Drawings exactly to ease checking and building maintenance procedures.

B. Equipment Bases: Ensure that concrete bases and foundations provided for installation of equipment are constructed in accordance with approved shop and construction drawings and equipment manufacturers' drawings and that holes for fixing bolts and provisions for passage of cables etc. are provided as required.

C. Cable Trenches: Ensure that trench construction and covers provided for installation of power and control cables are in accordance with approved shop and construction drawings.

D. Built-In Items: Ensure that equipment supports, fixings and the like, and sleeves for passage of feeders and cables which shall be built into concrete foundations, bases, cable trenches or building structure are provided as and when required and that they are properly installed.

E. Equipment: Install on concrete bases etc., and assemble completely plumb and level, before grouting in holding-down bolts.

F. Supports and Terminations: Install all incoming and outgoing cable supports, cable ends and termination fittings required for MV, LV and control cables.

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G. Relays: Set in accordance with manufacturer's instructions and the Local Power Authorities requirements.

H. Earthing: Ensure that earthing installation is as described in Division Y Section " Earthing And Bonding " of the Specification and/or as shown on the Drawings.

I. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, brackets, and temporary blocking of moving parts from switchgear units and components.

330.020 IDENTIFICATION

A. Identify transformers and install warning signs according to Division V Section "Basic Electrical Materials and Methods."

330.030 CONNECTIONS

A. Tighten bus joint, connector, and terminal bolts according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in applicable Standards.

330.040 FIELD QUALITY CONTROL

A. Equipment: Inspect equipment upon delivery to site and report any damage to Engineer.

B. Components: Check component ratings, types, sizes and wiring connections, including current and voltage transformers, fuses, switches, instruments and relays.

C. Manufacturer's instructions shall be followed under all circumstances. Carry out and record measurement and tests recommended by the manufacturer.

D. Test Objectives: To ensure transformer is operational within industry and manufacturer's tolerances, is installed according to the Contract Documents, and is suitable for energizing.

E. Test Labeling: On satisfactory completion of tests for each transformer, attach a dated and signed "Satisfactory Test" label to tested component.

F. Schedule tests and provide notification at least 7 days in advance of test commencement.

G. Report: Submit a written report of observations and tests. Report defective materials and installation.

H. Tests: Include the following minimum inspections and tests according to manufacturer's written instructions.

1. Inspect accessible components for cleanliness, mechanical and electrical integrity, and damage or deterioration. Verify that temporary shipping bracing has been removed. Include internal inspection through access panels and covers for dry-type transformers.
2. Inspect bolted electrical connections for tightness according to manufacturer's published torque values.
3. Insulation Resistance: Perform meg-ohmmeter tests of primary and secondary winding to winding and winding to ground.
4. Duration of Each Test: 10 minutes.
5. Temperature Correction: Correct results for test temperature deviation from 20 deg C standard.
6. Turns Ratio: Measure between windings at each tap setting. Measured ratios deviating more than 0.5 percent from calculated or measured ratio for an adjacent coil is not acceptable.
7. Winding Resistance: Measure for windings at nominal tap setting. Measured resistance, deviating more than 1 percent, from that of adjacent windings, is not acceptable.
8. Verification of the operation of the cooling system.
9. Liquid-Filled Transformer, Insulation Power-Factor Test: Determine overall dielectric loss and power factor for windings' insulation. Limit test voltage to line-to-ground voltage of windings being tested.
10. Functional test of all protective devices.

I. Test Failures: Compare test results with specified performance or manufacturer's data. Correct deficiencies identified by tests and retest. Verify that transformers meet specified requirements.

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330.050 GROUNDING

A. Comply with Division V Section "Earthing and Bonding" for materials and installation requirements.

330.060 CLEANING

A. On completion of installation, inspect components. Remove paint splatters and other spots, dirt, and debris. Repair scratches and mars on finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

330.070 ADJUSTING

A. After installing and cleaning, touch up scratches and mars on finish to match original finish.

B. Adjust transformer taps to provide optimum voltage conditions at utilization equipment throughout normal operating cycle of facility. Record primary and secondary voltages and tap settings and submit with test results.

330.080 DEMONSTRATION AND TRAINING

A. Train Employer's maintenance personnel to adjust, operate, and maintain the system installation. Refer to Division A Section "Demonstration and Training and Closeout Procedures."

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V11C - MEDIUM-VOLTAGE SWITCHGEAR

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. This Section includes medium-voltage switchgear and associated auxiliary equipment.

B. Description Of Work: medium voltage (MV) switchgear installations comprise the following:

1. Indoor metal-enclosed (LSC2A) MV switchgear.
2. Control power supply.
3. Equipment supports.
4. Earthing of switchgear.
5. Ancillary work.

a) Connection to BMS system of electrical power supply network, including interface elements such as relays, transducers, etc. as necessary and /or as shown on Drawings.

110.000 DESIGN PARAMETERS

110.010 PROJECT/SITE CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Employer or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Engineer not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Engineer's written permission.

110.020 REFERENCE STANDARDS

A. Standards: Equipment and component parts shall comply with the following Standards:

1. Common Clauses for HV Switchgear and Control Gear Standards: IEC 62271-1.
2. A.C. Metal-Enclosed Switchgear and Control Gear for Rated Voltages above 1 kV and up to and including 52 kV: IEC 62271-200.
3. HV A.C. Circuit Breakers: IEC 62271-100.
4. Insulation Coordination: IEC 60071.
5. HV A.C. switch-fuse combinations: IEC 62271-105.
6. A.C. Disconnectors (isolators) and Earthing Switches: IEC 62271-102.
7. HV Switches for rated voltages above 1 kV and less than 52 kV: IEC 62271-103.
8. Surge Arrestors: IEC 60099.
9. Metering and Protective Current Transformers (CTs): IEC 61869-2.
10. Metering and Protective voltage Transformers (VTs): IEC 61869-3.
11. Relays: IEC 60255.
12. Reading Instruments: IEC 60051.
13. Watt-Hour Meters: IEC 62052-11, 62053-11, 62053-22 & 60051.
14. Power Transformers: IEC 60076.
15. Sulfur Hexa-Fluoride: IEC 60376.
16. Fuses: IEC 60282-1.
17. Climate Conditions: IEC 60721-3-3 & 60721-3-4.

120.000 SYSTEM DESCRIPTION

120.010 GENERAL REQUIREMENTS

1. Busbars: high conductivity, electrolytic copper, modular, designed to withstand worst short-circuit conditions without allowing permissible temperature rise at ambient conditions to be

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exceeded, in accordance with the Standards. Busbar connection from one unit of switchgear to another shall be expansion/contraction compensated, plated and bolted. Bolted or clamped contact surfaces shall be properly tin or electro-silver plated as necessary. Busbar supports shall be flame-retardant, track-resistant, glass polyester, porcelain or equally reliable fiberglass reinforced epoxy to approved standards.

2. Busbars: shall be tin-plated and insulated either with epoxy insulation applied by the fluid-dip process or heat shrinkable insulating sleeves. Busbar connections shall be insulated with easily installed, performed vinyl boots, secured by nylon hardware.
3. Earth Bus: Copper of not less than minimum size required by the Standards, designed to withstand worst earth- fault current of power system without showing any signs of thermal or mechanical damage or degradation. Earth bus shall extend full length of switchgear.
4. Power Cable Terminations: Fixed bolted type, unless otherwise specified, complete with standard fittings and accessories for connection of incoming and outgoing cables. Cable compartment shall be designed to permit cables to enter enclosure and connect at respective terminals from below. Terminations are to include appropriate sealing ends, fittings, earthing straps and accessories for types of cables used, including stress cones or other stress relieving accessories, heat shrinkable sleeving, end boxes or end bushings and fittings of any kind necessary to support and protect specified cable.
5. Where single core cables are used, top / bottom cable entry plates shall be made of Aluminum with adequate thickness and rigidity to support cables.
6. All switchgear shall be provided with Local/Remote selector switch for controlling the switchgear either from local or remotely via BMS system.
7. Potential Indicators: Neon indicators shall be provided at front of each switchgear unit, one per phase, using capacitive potential divider to indicate voltage state on cable terminals.
8. Short circuit indicator: neon indicators are to be provided at front of each switchgear unit, one per phase, to indicate damaged section due to existence of short circuit.
9. The primary windings of VTs shall be protected by a HRC fuses.
10. The secondary windings of VTs shall be protected by MCBs located at the LV compartment. Each MCB shall be equipped with necessary auxiliary contacts for alarm, interlock, BMS interface, etc. applications.
11. All secondary circuits shall be wire with PVC insulated flexible 750V copper wires, with a minimum cross section of 1.5mm2 for control, alarms, signaling etc, and 2.5mm2 and 4mm2 for voltage and current circuits respectively.
12. The secondary circuits of the current transformers shall be connected to terminal blocks located inside the LV compartment. These terminal blocks shall be equipped with suitable built-in make before break shorting facilities.
13. DC supplies to each cubicle shall be protected by suitable MCBs equipped with necessary auxiliary contacts to give alarms in case of MCB trips.
14. Interlocks shall be provided on switchgear so that:

    a) Circuit breaker cannot be isolated, earthed or put into service position when closed.
    b) Access to cable compartments cannot be made unless earthing switch is closed.
    c) Earthing switch cannot be opened unless cable compartment is closed.

15. Keys and padlocks shall be provided for manually interlocking two or more units if required. Electrical and mechanical interlocks shall be provided for automatic safe and functional operation of the system as specified or shown on the Drawings/Schedules.
16. Earthing facilities shall be provided for earthing and/or short-circuiting the feeder at its terminals through built-in, safety-interlocked, quick-make earthing switch, without use of loose attachments.
17. Metal cases of instruments and control devices shall be connected by PVC insulated copper conductors of not less than 2.5mm2 cross-section to nearest earth bar.
18. Ferrules: Cable and wire ends shall be fitted with numbered ferrules of approved type at each termination. Colour coding shall be as required by the Regulations and the applicable Section of the Specification.
19. Test terminal blocks shall be provided inside insulating covered bases for instruments, instrument transformers, relays etc. in LV compartments.
20. Components shall be interchangeable when of same rating and function.
21. Finish: Inner and outer surfaces of steel enclosures and structure shall be cleaned, phosphatized, primed with rust inhibiting primer and finished with two coats of baked enamel, color standard

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gray (RAL 7033) unless otherwise approved. Finish shall be vermin and fungus proof and suitable for worst climatic conditions on site.

22. MV Switchgear Ratings:

    a) Rated Voltage: 24 kV.
    b) Nominal Service Voltage : 15 kV.
    c) Rated Frequency: 50 Hz.
    d) Rated One Minute Power Frequency Withstand Voltage (rms) to Earth and Between Phases: 50 kV.
    e) Rated Impulse Withstand-Voltage (1.2/50 micro-sec) (peak): 125 kV.
    f) Rated Normal Current of Busbars: (630/1250/1600/2000/2500 A) as shown on Drawings.
    g) Rated Short Time Withstand-Current: 20 kA for 1 second for metal enclosed LSC2A-PI or PM switchgear).
    h) Rated Peak Withstand-Current: 50 kA (for metal enclosed LSC2A switchgear).
    i) Passive internal arc classification for metal enclosed LSC2A switchgear or extandable ring main units (LSC2B or LSC2A) is designated as follows:

Classification IAC	AFL
Internal arc	20 kA 1 s

23. Auxiliary Power Supply Rating:

    a) Rated Supply Voltage of Closing and Opening Devices and Auxiliary Circuits: 110 or 125 D.C. V, as recommended by manufacturer.

120.020 INDOOR METAL-ENCLOSED SWITCHGEAR

A. Type: Air insulated type for installation indoor categorized (LSC2A-PI or PM), having a minimum of two high voltage compartments with insulated or metallic partitions in between and one point of disconnection per functional unit, comprising single busbar, floor mounted, free standing switchgear of modular construction, forming a continuous integral structure extendable at either end, with withdrawable mounted circuit breakers and three position switch disconnector per feeder or fixed breaker and three position switch disconnector per feeder, isolating disconnectors, and/or switch – disconnector-fuse combination, motorized switch disconnector, as specified or shown on the Drawings.

B. Switchgear shall have a degree of protection, against contact with live parts and against external effects, of IP 3X for enclosures and IP 2XC for partitions according to IEC 62271-1 and IEC 60529, when in the connected position.

C. Circuit Breakers: Frame mounted and bolted into position. Frame shall have wheels for handling during installation or maintenance.

D. Single air-break/SF6 isolator shall be provided, on busbar side of circuit breaker, interlocked with circuit breaker operation such that isolation or connection of the isolator is not possible while circuit breaker is closed. Isolators shall be pad lockable in the off and earth positions.

E. Compartmentation shall be provided by earthed metallic or insulated partitions between switching devices, busbars, cable terminations and LV equipment.

F. Mechanical interlock between the door and the switch disconnector's "Earth Position" shall be provided.

G. Control and monitoring of each unit shall be provided on front panel and shall include mimic diagram, operating handles of main device and earthing switches, position indicators, close and trip push buttons, potential indicators, identification and instruction plates, protective devices, metering and indicating instruments, key and padlockable devices, as specified and shown on the Drawings.

H. Access to LV wiring shall be from front of cubicle for control, protection, test terminal blocks and associated LV power connections. Multi-pin, disconnectable, lock-in type plug and socket arrangement shall be provided between circuit breaker and stationary part of cubicle.

I. Anti-condensation heaters with hygrostat, switch and pilot lamp and of rating recommended by manufacturer shall be provided in each section of switchgear assembly.

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J. Wiring diagram, suitably protected and located inside LV compartment of each unit, shall indicate all data and components related to the particular unit and its external circuitry.

120.030 MV CIRCUIT BREAKERS

A. Type: vacuum break circuit breaker or SF6 circuit breaker, with closed gas circuit, and with pressure detector to prevent operation of circuit breaker in case of loss of gas pressure within the sealed enclosure**.**

B. Circuit breakers used in ring main units shall be of class M1-E2 for mechanical and electrical endurances respectively to IEC 62271-100.

C. Circuit breakers used in metal enclosed (LSC2A) switchgears shall be of class M2-E2 for mechanical and electrical endurances respectively to IEC 62271-100.

D. Circuit breakers used in metal clad (LSC2B) switchgears shall be of class M2-E2-C2 for mechanical and electrical endurances and for restrike probability during capacitive current breaking respectively to IEC 62271-100.

E. SF6 breakers shall be provided with pressure switches, one per pole, to initiate alarm in case the pressure of the SF6 gas drops below manufacturer set values. Gas filling valves shall be provided unless sealed type circuit breakers are used. Gas status indicator shall be provided on circuit breaker front.

F. Particulars: In addition to the ratings specified in paragraph 120.010 22 "MV Switchgear Ratings" of Article 2.2**Error! Reference source not found.** "General Requirements" hereof, circuit breakers shall have the following ratings:

1. Rated Normal Current: As shown on Drawings.
2. Rated Short-Circuit Breaking Current at Nominal Service Voltage and 30 % Percentage D.C. Component in Accordance with IEC 62271-100: 20 kA (metal enclosed LSC2A switchgear).
3. Rated Short-Circuit Making Current (peak): 50 kA (metal enclosed LSC2A).
4. Rated Duty Operating Sequence: O - 3 min – CO - 3 min - CO.
5. Rated Transient Recovery Voltage (TRV) for Terminal Faults (peak) not exceeding: 30 kV otherwise, surge arrester shall be used on each main and outgoing feeder.
6. Rated Cable Charging Breaking Current: 30.5 kA.
7. Rated (single) Capacitor Breaking Current: 400 A minimum.

G. Operating Mechanism: Mechanically and electrically trip- free, stored energy, spring loaded, manually charged by lever or hand-crank, electrically charged by suitably rated universal motor, and capable of one complete off-on-off cycle in case of loss of control power. The operating mechanism shall include anti-pumping device and incorporate manual trip facility fitted with a guard. It shall be possible to manually discharge the springs. Circuit breaker shall have electrical close solenoid and one trip coil, mechanical on and off status indicator, mechanical and electrical on/off push buttons, mechanical indication of spring charged, non-resettable operation counter and auxiliary contacts to satisfy all functions specified or shown on the Drawings. Five N.C. and five N.O. spare auxiliary contacts for future use shall be provided in addition to those required different applications. All spare auxiliary contacts shall be wired to terminal blocks inside the LV compartment marked as spare. Auxiliary relays shall be provided where insufficient auxiliary contacts are available. Insertion of manual spring charging lever or hand- crank shall automatically disconnect the motor.

H. The tripping, closing and auxiliary functions shall be capable of operating at control voltages between 85 per cent and 110 per cent of the rated values.

I. Interchangeability: Circuit breakers of different current ratings shall not be interchangeable. Circuit breakers of same current rating shall be wired alike and interchangeable.

J. Mechanical endurances of circuit breakers shall be class M2 according to IEC 62271-100.

120.040 MV SWITCH-DISCONNECTORS AND SWITCH-FUSE COMBINATIONS (FOR INSTALLATION IN FIXED METAL-ENCLOSED SWITCHGEAR)

A. Switch-Disconnector: General purpose, 3-pole, load- break, short-circuit make, SF6 interrupter or vacuum interrupter type, equipped with gas pressure indicator with alarm contacts, class M1-E3 for

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mechanical and electrical endurances respectively to IEC 62271-103, providing positive break indication, as defined in IEC 62271-102, with contact position indicating device and reliable method of preventing any earth leakage currents passing from terminals of one side to terminals of other side of the switch-disconnector when in the open position.

B. Switch-disconnector operation shall be electrically and manually through handles at front of unit. Switching mechanism shall be manual, motor operated, spring charged, quick-make and quick-break, with speed of switching independent of operator. On/off control push buttons shall be provided for controlling the switch. Switch-disconnector shall have on and off positions, lockable in either position. Reliable mechanical indicator shall be provided for indicating the two positions.

C. Switch-disconnector earthing switch of the quick-make type, front operated (operation being independent of operator), class E2 for electrical endurance to IEC 62271-102, shall close onto cable terminals and be interlocked such that it will close only after load-break switch- disconnector and associated breaker are open. Earth blades shall be visible through an inspection window. Access to cable compartment shall be prevented unless earthing switch is closed.

D. Switch-Disconnector Ratings:

1. Rated Normal Current: 630 A.
2. Rated Short-Circuit Making Current (peak): 50 kA.
3. Rated Short Time Current: 20 kA for 1 sec.

E. Switch-Fuse Combination: 3-pole, trip-free, of similar construction to switch-disconnector, with set of three air- insulated fuses, in accordance with IEC 62271-105. Automatic trip switching shall be by fuse striker pins which actuate common trip-bar in switch mechanism. Once operated, striker pins remain in ejected position, preventing re-closure of switch until fuse has been replaced. Single phasing shall not be possible. Switch-Fuse combination shall have two earthing switches to earth both sides of fuses simultaneously by means of quick-make earthing switches, interlocked to operate after main switch is opened.

F. MV Fuses: High-breaking capacity, totally enclosed, cartridge type fuse-links, current limiting, with striker pins to cause switch to open. Fuses shall comprise fuse links and fuse bases insulated to respective standards. Fuses shall comply with IEC 60282-1.

G. Switch-Fuse Combination Ratings:

1. Rated Normal Current: 200 A.
2. Rated Short-Circuit Breaking Capacity: 20 kA.
3. Rated Short-Circuit Making Current (peak) to IEC 62271-105: 50 kA.
4. Rated Current of Fuse Link: as shown on drawings.

H. Switch-Fuse combination additional devices, where specified or shown on the Drawings, shall be provided as follows:

1. Shunt trip relay, operated by push buttons or relay as shown, using auxiliary power.
2. Under-voltage relay, operated by auxiliary power electrical closing device, geared motor connected to switch spring charging mechanism, with closing release, operated from auxiliary power supply.

I. Mechanical endurance shall be class M1 according to IEC 62271-103.

120.050 PROTECTIVE RELAYS, DEVICES AND AUXILIARIES

A. Protective Relays: Digital, programmable, solid state, static, sealed type, having high immunity to electric field, with modular design, suitable for operation at 55 deg. C ambient temperature, mounted in dust-tight steel enclosures with cover, with self supervision system test buttons for testing without removing from case, and built in self regulated power supply unit and installed where shown on the Drawings. Adjustments and settings shall be accessible and visible from front of relay. Performance shall be in compliance with IEC 60255-151, -8, -1 and IEC 60255-22 (Sections 1-4) and as applicable elsewhere in this specification.

B. Protective Relay: shall be supplied with DC power from the switchgear power supply, and to be provided with a pilot LED which shall be lit under healthy operating conditions. Relay shall be provided with a self supervision system which upon power supply interruption or a fault condition

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shall switch off the LED and to initiate an alarm. The rated current and voltage for current & voltage sensing relays shall match that of the corresponding current and voltage transformers of the switchgear respectively. The continuous rating of the output contacts shall not be less than 5A.

C. Interference and test voltages of the solid state relays shall be as follows:

1. Insulation test voltage, terminal groups between themselves and the relay frame work as per IEC 60255-5: 2 kV, 50 Hz, 1 min.
2. Impulse test voltage, terminal groups between themselves and the relay frame work as per IEC 60255-151: 5 kV, 1.2/50 micro sec.
3. High frequency test voltage, terminal groups between themselves and the relay framework as per IEC 60255-1: 2.5 kV, 1MHZ.

D. Over Current Relay: 3 phase, non-directional, solid state type with two setting stages as follows:

1. Low setting stage for overload protection with current setting range of 50 % to 250 % of rated current in steps of 5%, and adjustable definite time and inverse time operation modes as per IEC 60255-151.
2. High setting stage (instantaneous) for short circuit protection with current setting range up to 4000% of rated current.
3. For transformer protection the time and instantaneous units shall not operate on inrush or due to harmonic currents during transformer energization or on system faults. Separate additional harmonic restraint relays may have to be provided, if required based on the transformer manufacturer's data.

E. Directional Over Current Relay: 3 phase, directional, solid state type for overload protection with current setting range of 50 % to 250 % of rated current in steps of 5%, and adjustable definite time and inverse time operation modes as per IEC 60255-151.

F. Earth fault relay, non-directional, solid state type with two setting stages as follows:

1. Low setting stage of 10 % to 80 % of rated current and adjustable definite time and inverse time operation modes as per IEC 60255-151.
2. High setting stage (instantaneous) with current setting range up to 1000% of rated current.

G. Restricted earth fault relay, on secondaries of distribution transformers and generators having a solidly grounded neutral, where specified or indicated on the Drawings, shall be high impedance, instantaneous differential type, current calibrated from 1% - 20% of phase current.

H. Under-Voltage and Over Voltage Relays: three phase or three single phase, solid state definite time type with the following setting ranges:

1. Under Voltage Relay: 60 % to 90 % of rated voltage and 0.2 to 6 sec time delay.
2. Over Voltage Relay: 80 % to 130 % of rated voltage and 0.2 to 6 sec time delay.

I. Under-Voltage and Phase-Sequence Relays: Under-voltage relay shall be time-delay type, with selectable time/voltage characteristics 0.1 - 1.0 seconds for settings between 60% and 90% of normal voltage, sensed at VT secondaries. Combined under-voltage and phase-sequence relays shall be provided where specified or shown on the Drawings. Phase- sequence relay shall prevent operation (closing) of respective circuit breaker in case of non-conformance of phase rotation.

J. Each relay shall be provided with an interface data link (IEC 61850 or equivalent) and adequate number of contacts for tripping annunciation, and interface with BMS functions.

K. Auxiliary Relay: Suitably rated with sufficient number of N.O. and N.C. contacts for operation in conjunction with protective relays or control/interlocking requirements. Relay shall have two N.O. and two N.C. spare contacts.

L. Surge Arresters on Main Incoming Feeders: Gap-less, metal oxide, heavy duty type, silicon polymer housing with the following characteristics:

1. Arrester Rated Voltage: 15 kV.
2. Maximum Continuous Operating Voltage (Uc): 12.7 kV.
3. Nominal Discharge Current (8/20 micro-sec peak): 10 kA.
4. Energy Input Capacity**:** 3.5 kJ/kV.

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Surge arresters shall be vertical, free standing, explosion-proof type. Submit complete data and characteristics in accordance with IEC 60099 testing requirements and procedures.

M. Surge Arresters on Outgoing Circuit Breakers: Where specified or shown on the Drawings, surge arresters shall be gap-less, metal oxide, heavy duty type, silicon polymer housing with the following characteristics:

1. Arrester Rated Voltage: 12 kV.
2. Maximum Continuous Operating Voltage (Uc): 10.2 kV.
3. Nominal Discharge Current (8/20 micro-sec peak): 10 kA.
4. Energy Input Capacity: 3.5 kJ/kV.

Surge arresters shall be vertical, free standing, explosion-proof type. Submit complete data and characteristics in accordance with IEC 60099 testing requirements and procedures.

N. Control power supply shall be a complete system, including main LV switch, battery charger, batteries, racks and connectors, factory assembled and completely pre-wired to minimize field installation.

O. Batteries: Nickel cadmium type, of capacity sufficient to supply all MV switchgear auxiliary loads, relays, coils, lamps, alarms etc. for 8 hours, to close all circuit breakers in rapid succession, and trip all circuit breakers simultaneously with the charger off. Battery shall be heavy-duty type with transparent containers, maximum and minimum electrolyte level indicators and alarm initiating relay in case of D.C. output failure. Battery calculation shall be submitted according to IEEE 1115 based on simultaneous trip of all circuit breakers in T1 (1 minute) period, continuous load in T2 (478 minutes) period, and successive close of all circuit breakers in T3 (1 minute) period. Batteries shall be sized for nominal system voltage +10% -15%. Calculation shall consider the following factors:

1. 1.15 design margin.
2. 1.25 aging factor.

P. Battery Racks: Generously dimensioned termite resistant hardware with electrolyte resistant paint finish, or square sectioned steel tubes treated with electrolyte resistant extruded coating. Fittings and connectors shall be approved and certified electrolyte resisting and corrosion proof materials.

Q. Battery Charger: Automatic voltage controlled, solid state type, suitable for float and boost charging, returning batteries to 90% full charge within 4 hours after full discharge, plus full duty cycle required of batteries. Charger shall operate from 230 V supply, 50 Hz, three or single- phase, giving specified DC output and having minimum range of adjustment of 100% - 125% float voltage and 110% - 135% boost voltage. Ripple shall not exceed 1% of nominal output voltage. Output voltage regulation tolerance shall be +/- 1%. Output transient response shall be +/- 5% maximum of the DC voltage setting for 100% step load changes with recovery time of 500 m sec to steady state. Charger shall be rated 125% of its nominal full load and shall have its own automatic control against overcharging and overload protection. Charger shall have AC voltmeter, DC voltmeter, DC ammeter, main incoming circuit breaker, pilot lights on AC input and DC output, and earth fault detector with alarm indication. Battery charger sizing calculations shall consider the following:

1. 1.1 design margin.
2. 1.4 battery inefficiency factor.

R. Battery Charger Type: Dual charger-type, parallel redundant, with each module capable of carrying the full load requirements of the system.

120.060 METERING INSTRUMENTS - INSTRUMENT TRANSFORMERS

A. Provide metering Instruments and instrument transformers as specified and/or shown on the drawings.

B. Instruments Generally: Housed in enameled, square steel cases for switchboard flush installation, size 96 x 96 mm with 5 mm frontal, protected and sealed white background dials with black pointers (in general) and anti- parallax shadow-proof glass covers. Accuracy of instruments shall be class 1.5 unless otherwise specified. Moving parts shall be damped, revolving on hard-stone bases, with zero adjustment screw.

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C. AC Voltmeters: Moving iron type, operating from VT secondaries, and with the following characteristics:

1. Measuring Range: 1.25 x system nominal voltage in kV with red line marked on nominal voltage, 250 degrees decimal scale.
2. Overload Factor: 1.2 times rated voltage continuous and twice rated voltage for 1 minute.

D. DC Voltmeters: Moving coil type, with the following characteristics:

1. Measuring Range: 1.25 x D.C. aux. power voltage V.
2. Overload Factor: 1.2 times rated voltage continuous and twice rated voltage for 1 minute.

E. Voltmeter Selector Switch: 7-position, rotary type, with cam-operated contacts, permitting line-to-line and line- to-neutral voltage readings, and with off position.

F. AC Ammeters: Moving iron type, operating from CT secondary, and with the following characteristics:

1. Measuring Range :1.25 CT primary amps, 250 degrees decimal scale
2. Overload Capacity: 1.2 times measuring range continuous, twice measuring range for 2 minutes, and fifty times measuring range for 1 second.

G. DC Ammeters: Moving coil type, with the following characteristics:

1. Measuring Range: 2 x normal D.C. range A.
2. Overload Capacity: Ten times measuring range for 5 seconds.

H. Power Factor Meters: Totally enclosed, 3-phase, electro- dynamic type, with cross-coil meter movement and accuracy of 1% from at least 20% - 100% rated current at rated voltage.

1. Measuring Range: 0.1 conductive-unity-0.1 capacitive

I. Watt-meters: Totally enclosed, 3-phase, electro-dynamic type, with overload factor of 1.2 times continuous.

1. Measuring Range: 1.25 x rated kW.

J. Watt-Hour Meters: 3-phase, to IEC 62052-11, 62053-11, 62053-22 and IEC 60051, unless otherwise required by the Local Power Authority, for operation from 5 A CT secondaries.

K. Frequency Meters: Vibration (reed) type, rated frequency 50Hz, class 1, rated frequency range 45-55Hz, and unaffected by voltage variations of +/-20%.

L. Current Transformers (CTs): Indoor dry type (cast- resin), with the following characteristics:

1. Metering (general): Class 0.5, 5 A secondary.
2. Protection: Class 5P20, 5 A secondary.
3. Continuous rating Factor: 1.2.
4. Troid current transformer enclosing the three phase conductors shall be provided for zero sequence earth fault protection where required on drawings.
5. Tariff Kilowatt-Hour-Metering: Class 0.2 A secondary.
6. Current transformers for all types of differential and restricted earth fault protection shall be class PX to IEC 61869-2.
7. Characteristic of CT including knee point voltage (V_k), maximum magnetizing / exciting current (I_{mag} @ V_k) and CT secondary resistance (R_{ct}) shall be submitted for Engineer's approval by the Contractor as part of his CT calculation.

Rated primary current, core size and accuracy limit factors shall be determined in accordance with nominal current of plant protected, short-circuit level and burden. CT shall perform under specified conditions without exceeding accuracy limit. Submit error curves for approval. Thermal short-circuit rating shall be the same as specified for the MV switchgear with dynamic short-circuit rating of 2.5 times thermal rating.

M. Voltage Transformers (VTs): Magnetic, single-phase, indoor, dry type (cast-resin), with the following characteristics:

1. Rated Voltage:

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a) Primary: 15/√3 kV.
b) Star Secondary / Secondaries: 110/√3 V.
c) Open Delta Secondary: 110/3 V.

2. Accuracy Class: 0.5 for metering and 3P for protection.
3. Rated Voltage Factor: 1.2 continuous, 1.9 for 30 seconds.

Check associated burden and ensure VT can perform satisfactorily under specified conditions. Submit error curves for approval.

120.070 MICROPROCESSOR BASED METERING AND MONITORING UNIT

A. General: A microprocessor based metering unit shall be provided on the incoming and/or outgoing feeder panels of the MV switchgear as shown on the drawings. Unit shall be capable of monitoring and displaying the functions listed below and the capability to communicate data. Unit shall be similar to Cutler Hammer / Eaton Corp (UK) type IQ DP-4000 or other equal and approved.

B. Direct reading metered values shall be displayed by the unit as follows:

1. AC amperes in each phase, +/-0.5% accuracy
2. AC voltage, phase to phase, phase to neutral, +/-0.5% accuracy
3. Megawatts, +/-1% accuracy
4. Megavars, +/-1% accuracy
5. Megavoltamperes, +/-1% accuracy
6. Power factor, +/-2% accuracy
7. Frequency, +/-0.1 Hz accuracy
8. Megawatt demand (5,10,15,30 minute interval field programmable), +/-1% accuracy
9. Megawatt , megavars and VA hours, +/-1% accuracy
10. %THD , +/- 1%

C. Unit shall be provided with an interface data link (IEC 61850 or equivalent) for connection with BMS systems.

D. Control power shall be drawn from the monitored incoming AC line terminal connections. Device shall have non-volatile memory and does not require battery backup. In the event of a power failure, the device shall retain preset parameters.

E. Unit shall allow user to disable undesired values or functions and to later reactivate them if required. In the event of trip or alarm condition, a built-in reset button shall allow a manual reset of the unit. Unit is also to be capable of being remotely reset via its communication port.

F. Addressable communication card shall be provided for interfacing with BMS system, for transmission of all data, including trip data.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and Division A Specification Sections, apply to this Section.

210.000 RELATED SECTIONS

A. Related Sections include the following:

1. Division V Section "Basic Electrical Materials and Methods".
2. Division Y Section "Earthing and Bonding ".
3. Division Y Section "Medium-Voltage Cables" for cable terminations at switchgear.
4. Division W Section "Central Control / Building Management ".

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PART 3 PRODUCTS AND WORKMANSHIP

300.000 MATERIALS

300.010 MANUFACTURERS

A. Approved Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

1. ABB
2. G.E.
3. Schneider Electric
4. Siemens
5. Cuttler Hammer/Eaton corp.

B. Locally assembled products by one of the above approved manufacturers are acceptable subject to compliance with design requirements and adequacy of reference list and quality control of the local factory.

300.020 PRODUCTS

A. Products: Subject to compliance with requirements, provide one of the products indicated for each designation as shown on plans.

310.000 QUALITY MANAGEMENT

310.010 QUALITY ASSURANCE

A. Manufacturer Qualifications: Engage a firm experienced in manufacturing switchgear similar to those indicated for this Project and with a record of successful in-service performance.

310.020 DELIVERY, STORAGE AND HANDLING

A. Deliver in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.

B. Deliver, store, and handle materials, components, and equipment as per Manufacturer’s instructions.

310.030 COORDINATION

A. Coordinate layout and installation of switchgear with other construction and room dimensions. Advise the Engineer in case of conflict.

B. Coordinate size and location of concrete or mounting bases. Concrete, reinforcement, and formwork requirements are specified in Division E Section "Accessories Cast Into In Situ Concrete."

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division H Sections.

310.040 WARRANTY

A. Manufacturer’s Warranty: Submit a written warranty signed by the manufacturer agreeing to repair, restore or replace any defective equipment specified in this section during the specified warranty period Warranty Period: 1 year from date of Substantial Completion

310.050 FACTORY ACCEPTANCE TEST

A. Factory acceptance tests of equipment under this Contract are subject to be witnessed by the Engineer for locally assembled equipment. Witness test shall include complete routine and function testing on all units to be witnessed. Test procedure and program shall be submitted for approval prior to test conduction. Allow for test expenses including business class transportation and hotel accommodation as necessary for two persons from the Engineer’s/ Employer’s side.

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310.060 SPARE PARTS AND EXTRA MATERIAL

A. Spare Parts: Provide spare parts, as recommended by the manufacturer, for one year maintenance as expected under local conditions, and to allow for emergency replacement due to accidental breakage or failure. Spare parts shall include, but are not limited to, the following:

1. Two sets of each type of lamp, fuse, auxiliary switch, trip coil, control switch, selector switch, neon indicator and the like.
2. Complete set of main contacts of each rating.
3. Complete set of breaker/switch auxiliary contacts.
4. Complete mechanism of breaker/switch of each type.
5. Drive motor of each type.

B. Tools and Instruments: Provide tools and instruments required for normal routine inspection, testing, operation and maintenance including levering crank, manual charging handle, manual shutter operator, testing jumpers and HV test bushings, set of rail extensions, digital micro ohm-meter, set of mobile lifting and handling equipment etc. as necessary for the type of switchgear.

320.000 SUBMITTALS

A. Product Data: Submit full technical data of equipment for approval including, but not limited to, the following:

1. Manufacturers' catalogues, detailed description of construction, provisions for extension, compliance with the Standards, dimensions and weights, operating characteristics, operating curves and error curves (VT, CT) for all switchgear, control gear, protective gear, metering gear etc.
2. Details of miscellaneous items including pilot lights, cabling or wiring, incoming and outgoing feeder terminal fittings, supports, labels, interlocks, bracing etc.

B. Shop and Construction Drawings: Submit drawings for approval including, but not limited to, the following:

1. Plans and elevations, with indication of switchgear mounted components, dimensions and weights.
2. Arrangement of equipment and general layouts.
3. One-line diagram of power system showing current ratings of switchgear and busbars and types and locations of protective gear (relays, metering instruments, CTs, VTs) etc.
4. Schematic and elementary diagrams of control circuits.
5. Block diagrams for BMS interface points.
6. Foundation details, grouting holes and installation details.
7. Physical arrangement of incoming and outgoing feeders, instrument transformers, busbars, connections etc.
8. Dimensions and weights of control power supply and other auxiliary equipment or components.
9. Calculation of current and voltage transformers characteristics to verify their suitability for proper unsaturated operation under site fault condition and their adequacy for relay/wires/metering requirements.

C. Point-wise compliance statement to the specifications, duly signed by the manufacturer / manufacturer’s authorized representative and the contractor.

D. Technical Literature: Submit the following for approval prior to equipment manufacture:

E. Schedule of selected circuit breakers, relays and control gear, with complete identification of each component and its characteristics.

F. Type Test Certificates: Submit to verify compliance of main equipment with the relevant IEC Standards, including the following:

1. Impulse withstand-voltage tests
2. Power frequency withstand-voltage tests.
3. Temperature-rise tests.
4. Short time current tests.
5. Verification of making and breaking capacity.
6. Mechanical endurance/operation tests.

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7. Verification of degrees of protection for persons against contact with live and moving parts.
8. Internal arc tests.
9. Protection degree test to IEC 60529.

G. Routine Tests: Each complete switchgear unit shall undergo routine tests at the manufacturer's works in accordance with the relevant standards.

H. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

I. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

J. Maintenance Data: For switchgear to include in the maintenance manuals as specified in Division 01 and to the satisfaction of the Employer's requirements.

K. Submit a list of spare parts and tools required for 5 years of operation as expected under local conditions. Include part and drawing numbers, current unit prices, and source of supply.

L. Coordination Study: Submit protection coordination study, including pick-up settings and time-grading, together with time-current curves, equipment damage curves and range of adjustments etc. as required to coordinate with upstream and downstream protective devices of the complete system based on coordination curves of protective devices used and specific calculated prospective short circuit currents at various points.

330.000 EXECUTION

330.010 INSTALLATION

A. Locations and Layout: Exact locations and physical layout of equipment and components may be varied as required to suit manufacturer's design and as approved, provided the required functions and operations are accomplished; follow the identification of the units indicated on Drawings exactly to ease checking and building maintenance procedures.

B. Equipment Bases: Ensure that concrete bases and foundations provided for installation of equipment are constructed in accordance with approved shop and construction drawings and equipment manufacturers' drawings and that holes for fixing bolts and provisions for passage of cables etc. are provided as required.

C. Cable Trenches: Ensure that trench construction and covers provided for installation of power and control cables are in accordance with approved shop and construction drawings.

D. Built-In Items: Ensure that equipment supports, fixings and the like, and sleeves for passage of feeders and cables which shall be built into concrete foundations, bases, cable trenches or building structure are provided as and when required and that they are properly installed.

E. Equipment: Install on concrete bases etc., and assemble completely plumb and level, before grouting in holding-down bolts.

F. Supports and Terminations: Install all incoming and outgoing cable supports, cable ends and termination fittings required for MV, LV and control cables.

G. Relays: Set in accordance with manufacturer's instructions and in compliance with local Utility requirements.

H. Earthing: Ensure that earthing installation is as described in Division 26 Section "Grounding and Bonding for Electrical Systems" of the Specification and/or as shown on the Drawings.

I. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, brackets, and temporary blocking of moving parts from switchgear units and components.

330.020 IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs as specified in Division V Section "Basic Electrical Materials and Methods."

B. Diagram and Instructions: Frame under clear acrylic plastic on the front of switchgear.

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1. Operating Instructions: Printed basic instructions for switchgear, including control and key-interlock sequences and emergency procedures.
2. Storage for Manual: Include a rack or holder, near the operating instructions, for a copy of the maintenance manual.
3. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads.

330.030 CONNECTIONS

A. Tighten bus joint, connector, and terminal bolts according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in applicable Standards.

330.040 FIELD QUALITY CONTROL

A. Equipment: Inspect equipment upon delivery to site and report any damage to the Engineer.

B. Switchgear: Inspect and check switchgear for completeness and as recommended by the manufacturer and check phasing of buses, contact alignment and clearances.

C. Components: Check component ratings, types, sizes and wiring connections, including current and voltage transformers, fuses, switches, instruments and relays.

D. Before energization carry out at least the following tests:

1. Insulation resistance on busbars (with circuit breakers in disconnected position), circuit breakers, bushings and insulators, feeder terminals etc., using at least a 5 kV megger for MV circuits and a 1000 V megger on all control and protection circuits, with relays, lamps and the like components disconnected, to ensure satisfactory insulation resistance as recommended by the Standards and approved practices.
2. High voltage tests on busbars, while circuit breakers, switches and VTs are in disconnect position by applying HV AC test voltage between phases and phase to earth at 80% of the IEC voltage withstand test for 1- minute.
3. Resistance across closed contacts of circuit breakers using appropriate micro-ohm meter.
4. Functional test of circuit breakers, switches, earth switches, interlocking, protection, alarms, interface with BMS system, etc.
5. Polarity check and ratio tests for CTs.
6. CT transformation ratio.
7. VT polarity test.
8. VT transformation ratio.
9. Calibration checks and adjustment for ammeters and voltmeters.
10. Primary and/or secondary injection tests to check relay operation, using appropriate test sets, followed by tripping of circuit-breaker once only, through its protective relay circuit.

E. Cables: With circuit breaker in disconnected position, ensure that HV testing of feeder cable and respective termination is carried out as required under cable tests.

F. After energization carry out inspection and checking as follows:

1. Breakers shall be closed, one at a time, with as little load on the feeder as possible; check meters as load is increased and any indication of overheating detected by appropriate instruments or sensors.
2. Open and withdraw circuit breaker after a prolonged test run, inspect and check circuit breaker conditions, isolating contacts, contacts on all instruments and control switches, connections at terminal blocks etc., busbar connections and busbars for any indication of overheating; check for loose connections and bolts etc. and finally re-apply megger tests to ensure same quality of insulation as before energization.
3. Close circuit breaker slowly, while in the disconnected position and inspect contacts and/or contact movement and compare with design figures.

G. Manufacturer's instructions shall be followed under all circumstances. Carry out and record measurement and tests recommended by the manufacturer.

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330.050 CLEANING

A. Inspect interior and exterior of installed switchgear. Remove paint-splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

330.060 DEMONSTRATION AND TRAINING

A. Train Employer's maintenance personnel to adjust, operate, and maintain the system installation.

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V21A - INTERIOR LIGHTING

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. This Section includes interior lighting fixtures, lighting fixtures mounted on exterior building surfaces, lamps, ballasts, emergency lighting units, mounting provisions and connection to circuit wiring and to corresponding lighting control equipment.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Standards: Comply with the following Standards:

1. LED Fixtures:

a) IEC 60598 “Luminaires”.
b) IES LM-79-08 “Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products”.
c) IES LM-80-08 “Approved Method: Measuring Lumen Maintenance of LED Light Sources”.
d) IES TM-21-11 “Projecting Long Term Maintenance of LED Light Sources”.
e) EN 55015 “Limits and Methods of Measurement of Radio Disturbance Characteristics of Electrical Lighting and Similar Equipment”.
f) IEC 62471 “Photobiological Safety of Lamps and Lamp Systems”.

2. LED Drivers:

a) IEC 61347-1 “Lamp Controlgear - Part 1: General and Safety Requirements”.
b) IEC 61347-2-13 “Lamp Controlgear - Part 2-13: Particular Requirements for D.C. or A.C. Supplied Electronic Controlgear for LED Modules”.
c) IEC 62384 “DC or AC Supplied Electronic Control Gear for LED Modules - Performance Requirements”.
d) IEC 61000-3-2 “Electromagnetic Compatibility (EMC) - Part 3-2: Limits - Limits for Harmonic Current Emissions (Equipment Input Current ≤ 16 A per Phase)”.
e) EN 55015 “Limits and Methods of Measurement of Radio Disturbance Characteristics of Electrical Lighting and Similar Equipment”.
f) IEC 61547 “Equipment for General Lighting Purposes - EMC Immunity Requirements”.
g) IEC 62031 “LED Modules for General Lighting – Safety Specifications”.

120.000 SYSTEM DESCRIPTION

120.010 LIGHTING FIXTURE CONSTRUCTION - GENERAL

A. Generally: Construction and wiring of fixtures shall comply with the Regulations and Standards. Fixtures shall be fabricated, assembled and wired entirely at factory. Manufacturer's name, factory inspection stamp and official quality label shall be fixed to each fixture supplied.

B. Lighting Fixtures (Luminaires): Manufacturer's standard, as given in Lighting Fixture Schedules shown on the Drawings, or equal.

C. Sheet Steel Housings: Not less than 0.6 mm thick, and thicker when required by the Specification or the Standards.

D. Sheet Steel Reflectors: Not less than 0.5 mm thick.

E. Aluminum Reflectors: Not less than 99.5 % purity and not less than 0.7 mm thick, unless otherwise approved.

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F. Fabrication: Metalwork shall be mitred, welded and ground smooth without tool marks or burrs. Flat metal parts shall be stiffened by forming grooves and edges during fabrication. Metal parts shall have finish free from irregularities.

G. Rust-proof Ferrous Base: Ferrous metal parts shall be bonderized (treated with corrosion resistant phosphate solution) and given an approved rust-inhibiting prime coat before application of final finish.

H. Finish for Non-Reflecting Metal Surfaces: Approved baked enamel paint. Paint color on fixture frames and trims shall be as specified or as selected by the Engineer.

I. Finish for Light Reflecting Surfaces: White baked enamel paint having reflection factor not less than 85%. Mirror reflectors, where specified, shall be highly polished, anodized aluminum with reflection factors not less than 97%.

J. Mechanical Resistance of Finish: After finish has been applied on steel surfaces and cured, it shall withstand a 6 mm radius bend without showing signs of cracking, peeling or loosening from base metal.

K. Resistance of Finish to Ultra-Violet: Finish shall withstand 72 hours exposure to an ultra-violet RS lamp placed 100 mm from surface without discoloring, hardening or warping, and shall retain the same reflection factor after exposure.

L. Heat Resistance: Finishes, wires and components inside fixtures shall be certified materials to resist the temperatures or other conditions encountered in the fixtures.

M. Lamp Cap Temperature Rise Test: Comply with IEC 60360 when testing incandescent or discharge lamps for compliance with the limits for each type of lamp.

N. Wiring Inside Fixtures: Not less than 0.5 mm2, and insulated for 240 V application. Insulation shall have acceptable characteristics to resist maximum temperatures inside fixtures. Wiring shall be terminated on screw type, fixed, insulating, terminal blocks.

O. Hinges: Fixtures with visible frames and hinged diffusers shall have concealed hinges and catches, and stain-less steel retaining clips. Other alternative equally durable products may be submitted for approval.

P. Suspension Aligners: Provide for pendant fixtures for axial, vertical and horizontal alignment. Vertical adjustment shall be minimum 25 mm.

Q. Recessed Fixtures: Construct to fit into suspended ceilings without distorting fixture or ceiling. Plaster rings shall be provided for plaster or concrete ceilings.

R. Recessed down light fixtures shall be provided with “trims” to architectural approval and shall not have visible fixing screws or clips.

S. Outdoor Fixtures: UV resistant, non-ferrous metal or specially molded material for outdoor use.

T. Removal of parts for maintenance shall be possible without removing fixture housing.

120.020 LIGHT EMITTING DIODE (LED) LIGHTING FIXTURES - GENERAL

1. Light emitting diode shall be a solid state device embodying a p-n junction, emitting optical radiation when excited by an electric current. It shall be part of the LED module which is supplied as a light source. Output color consistency shall be guaranteed and have a Color Rendering Index (CRI) greater than 80 measured in accordance with IES LM-79-08, unless otherwise indicated on drawings.
2. LED luminaires shall comply with IEC 60598.
3. LED luminaires shall be protected against electric shock by means of basic insulation along with either of the following additional safety precautions:
    a) Earthing accessible conductive parts such that these parts cannot become live in case of basic insulation failure (Class I to IEC 60598).
    b) Providing double insulation or reinforced insulation with no provisions for protective earthing (Class II to IEC 60598).

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4. LED luminaires' efficacy shall be as shown on Drawings or 75 lumen per watt whichever is more stringent.
5. Guaranteed rated life (L80B50) shall not be less than 50,000 hours at 25 deg. C, as per IES LM-80-08, Approved Method: Measuring Lumen Maintenance of LED Light Sources and IES TM-21-11, Projecting Long Term Maintenance of LED Light Sources.
6. Luminaires guaranteed lifetime shall cover all fixtures components including lamp, fixture and drivers.
7. LED luminaires shall be suitable for 24/7 continuous operation at 50 deg. C with no negative effect on the specified luminaire life time at 50 deg. C and / or performance in terms of color temperature shifting and lumen output.
8. LEDs shall comply with Photo-biological Safety of lamps and lamp systems in accordance with the requirements of IEC 62471. Provide a test report to prove the fixture is classed as "Exempt" or "Risk Group 1".
9. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires, unless more stringent requirements are indicated on Drawings.
10. EMI/RFI shall meet EN 55015 requirements.
11. The maximum percentage of direct up-light from the outdoor luminaires shall be as CIE 126-1997.
12. Housing, for non-linear luminaires, shall incorporate an adequate heat sink, the design of the heat sinks shall be such that there is a direct thermal path from the LED junctions to the atmosphere thus providing a thermal transfer effect throughout the life of the luminaire which ensures the overall fittings and the LEDs are kept relatively cool and any heat generated throughout the life of the fixture at the specified ambient temperature doesn't affect the guaranteed life time and / or luminaire performance.
13. Linear LED lighting strips shall comply with the following in addition to the general requirements listed above:

    a) Linear LED strips shall be provided in flexible lengths as required by the installation conditions.
    b) Linear LED lighting strips characteristics in terms of IP rating shall suit the area of installation and as shown on Drawings.
    c) Linear LED lighting strips characteristics in terms of flexibility shall suit the method of installation (curved or linear) and as shown on Drawings.
    d) Linear LED construction shall be properly designed to ensure adequate heat dissipation from the LED junctions to the atmosphere to ensure that the overall strip is kept relatively cool and any heat generated throughout the life of the strip at the specified ambient temperature doesn't affect the guaranteed life time and / or luminaire performance.
    e) Linear LED strip channels/profiles degree of protection shall match the specified IP rating and shall ensure proper heat dissipation throughout the life of the strip such that the guaranteed life time is not affected.
    f) Linear LED strip power rating (W/m) shall be within 10% of the specified value.
    g) Maximum strip length connected to each LED driver shall be as per manufacturer's recommendation considering the distance from fixture, power and wire cross section.

14. Electronic LED Drivers: high efficiency, high power factor, suitable for operation at the ambient conditions specified for the project. Driver shall have constant output current or constant output voltage over the whole wattage range independent of mains supply fluctuations as shown on drawings and sufficient for operating the number and wattage of LEDs connected. Guaranteed rated life of the driver shall be 50,000 hours as a minimum.
15. LED drivers shall have electrical insulation between primary and secondary sides. Secondary cables from the driver to LED modules shall be provided by the LED supplier. Maximum length between driver and LED module shall be as per manufacturer's recommendations.
16. LED driver shall be protected against electric shock, accidental contact with live parts, short circuit, overload, over temperature where the output current is reduced if the temperature limit is exceeded.
17. In case LED luminaire internal temperature monitoring is required then the LED driver shall be provided with the possibility to connect a temperature sensor to monitor the LED temperature and protect the LED modules against thermal damage.
18. Dimmable driver, where required, shall be compatible with the dimming system used.

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19. Drivers shall be compatible with the lighting control system used such as; 1-10V, DALI, DMX, etc...
20. LED driver shall be provided with constant light output function, where required on Drawings, in order to maintain the light output of the LED by increasing the LED driving current over the lifetime.
21. LED driver shall comply with IEC 61347-1, IEC 61347-2-13 and IEC 62384 and shall meet the limits of main harmonic content as defined in IEC 61000-3-2 and comply with radio interference suppression limits defined in BS EN 55015 and immunity requirements of IEC 61547.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and Division A Specification Sections, apply to this Section.

210.000 RELATED SECTIONS

A. Division V Section "Basic Electrical Materials and Methods".

PART 3 PRODUCTS AND WORKMANSHIP

300.000 MATERIALS

300.010 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide one of the products indicated for each designation in the Lighting Fixture Schedule shown on Drawings or approved equal.

300.020 PRODUCTS

A. Products: Subject to compliance with requirements, provide one of the products indicated for each designation in the as shown on plans.

310.000 QUALITY MANAGEMENT

310.010 QUALITY ASSURANCE

A. Fixture Design and Standards: The Specification and the Drawings are a guide to the selection of lighting characteristics and lighting fixtures, giving general features of construction, materials, method of installation and conditions of operation. Unless otherwise specified, fixtures shall be manufacturer's standard series, designed and manufactured for the purpose and application required, generally in accordance with the Schedule of Lighting Fixtures and complying with IEC 60598 and BS EN 55015.

B. Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard.

C. All fixtures and accessories selection shall be in accordance of MINEA general specifications.

310.020 COORDINATION

A. Design Layout: Fixture layout has been determined from photometric data of specified fixtures to achieve desired level and uniformity of illumination. Reflected ceiling plans shall be checked to ensure exact positions of fixtures with respect to structural members, ducts, pipes, other installations and ceiling panels/tiles, where required. Certain fixtures are shown in provisional positions, pending preparation of final equipment layout drawings. Such fixtures shall be located in coordination with final equipment layout so that illumination is as intended by the design.

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B. Fixtures, Mounting Hardware, and Trim: Coordinate layout and installation of lighting fixtures with ceiling system and other construction.

310.030 SPARE PARTS AND EXTRA MATERIAL

A. Furnish extra materials described below that match product installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fully Equipped Lighting Fixtures: 1% of each type and rating installed. Furnish at least one of each type.
2. Control Gears: 1% of each type and rating installed. Furnish at least one of each type.

320.000 SUBMITTALS

A. Equipment Data: Submit data for approval including, but not limited to, the following:

1. Detailed literature on each fixture, lamp and control gear including manufacturer's name, catalogue number, rating, material specification, overall dimensions, operating characteristics and principles
2. Details of changes to standard fixtures for adaptation to condition of installation and to the Specification
3. Photometric data for lighting calculations provided as IES or LDT format including polar light distribution curves, coefficient of utilization, glare classification, efficiency, depreciation factors etc.
4. Dimensions of fixtures.
5. Certified results of accredited manufacturers' laboratory tests for fixtures and lamps for photometric performance.
6. For LEDs: Photometric test reports from accredited manufacturer's laboratories shall be submitted verifying the luminaire photometric characteristic; the testing shall conform to LM-79-08 or similar and approved international equivalent standard. Report shall include laboratory name, report number, date, luminaire catalogue number, luminaire, light source specifications, etc…
7. Battery and Charger Data: For self-contained emergency lighting fixtures.
8. Fluorescent and high-intensity-discharge ballasts.
9. Cold cathode and LEDs drivers.
10. Energy-efficiency data.
11. Life, output (lumens, Color temperature, and CRI) and energy efficiency data for lamps. Lifetime for LED fixtures shall be indicated at an ambient temperature of 25 and 50 deg. C.
12. Photo biological risk assessment for LED fixtures.
13. Types of lamps.

B. Shop and Construction Drawings: Submit Drawings for approval including, but not limited to, the following:

1. Exact position of each fixture on reflected ceiling plans, with indication of ceiling features, structural members, ducts, pipes and other fittings, as applicable and pertinent to the installation.
2. Installation details including suspension and mounting provisions.
3. Purpose made fixtures or lighting assemblies with full details.
4. Wiring details, circuit and panelboard references, special lighting control arrangements etc.

C. Samples: Submit fully equipped sample of each fixture type, modified if required, together with color and texture samples of each fixture.

D. Installation instructions.

E. Coordination Drawings: Reflected ceiling plans and sections drawn to scale and coordinating fixture installation with ceiling grid, ceiling-mounted items, and other components in the vicinity. Include work of all trades that shall be installed near lighting equipment.

F. Product Certificates: Signed by manufacturers of lighting fixtures certifying that products comply with requirements.

G. Test Certificates: Submit certificates demonstrating LED fixtures compliance with the referenced standards. Include the following as a minimum:

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1. Degree of Protection to IEC 60529.
2. Humidity Proof to IEC 60598.
3. Insulation resistance and electric strength to IEC 60598.
4. Color rendering for LED fixtures to IES LM 79-08.
5. LED fixtures lifetime to IES LM-80-08 and IES TM-21-11.
6. Efficacy to IES LM-79-08.

H. Dimming Ballast Compatibility Certificates: Signed by manufacturer of ballast certifying that ballasts are compatible with dimming systems and equipment with which they are used.

I. Addressable Ballast Compatibility Certificates: Signed by manufacturer of ballast certifying that ballasts are compatible with the central battery systems and equipment with which they are used.

J. Maintenance Data: For lighting fixtures to include in maintenance manuals specified in Division 1.

330.000 EXECUTION

330.010 INSTALLATION

A. Generally: Install fixtures level, aligned and parallel or square to building lines and at uniform heights as shown on the Drawings or as approved by Engineer. Make final height adjustment after installation.

B. Fixture Support: Provide fixture and/or fixture outlet boxes with hangers, brackets and flanged bolted fittings, as necessary, to support weight of fixture. Submit details of hangers etc. and method of fastening for approval. Rigidly secure fixtures mounted on outlet boxes to fixture studs. Install hooks or extension pieces, when required, for proper installation. Provide one point of support in addition to the outlet box fixture stud for individually mounted fixtures longer than 600 mm.

C. Remote Mounting of Ballasts: Distance between the ballast and fixture shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.

D. Stem Hangers: Provide two stem hangers for individually mounted pendant fixtures. Stems shall have suspension aligners and shall be of suitable length for suspending fixtures at required height.

E. Suspended Ceilings: If ceiling construction is unable to support weight of fixtures without strain or deformation, suspend fixtures directly from building structure.

F. Solid Ceilings: Coordinate dimensions of recesses in ceilings with exact fixture dimensions and structural elements.

G. Continuous Rows: Arrange fixtures so that individual fixture can be removed without dismantling remaining fixtures. Provide minimum spacing between fixtures.

H. Cover Plates: Install cover plates over fixture outlet box or opening in ceiling or structure when left unused.

I. Flush Recessed Fixtures: Install to completely eliminate light leakage within fixture and between fixture and adjacent finished surface.

J. Ventilation: Keep ventilation channels free after fixture is installed, if required by the design of the fixture. Ensure that the final circuit connection is adequately protected against heat transfer from fixtures.

K. Earth metal frames as described in Division Y Section " Earthing And Bonding ".

L. Tightness: Ensure that enclosed fixtures are reasonably insect/dust tight when installed, and completely weather- proof for installations subject to weather conditions. Installation of fitting and termination of circuit wiring should not invalidate the ingress protection rating.

M. Lamps for Permanent Installation: Place new lamps in fixtures immediately prior to hand-over and when instructed by Engineer. Lamps used for temporary service shall not be used for final lamping of fixtures.

N. Fixtures: Set level, plumb, and square with ceiling and walls, and secure according to manufacturer's written instructions and approved submittal materials. Install lamps in each fixture.

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O. Support for Fixtures in or on Grid-Type Suspended Ceilings: Use grid for support.

1. Install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 150 mm from fixture corners.
2. Support Clips: Fasten to fixtures and to ceiling grid members at or near each fixture corner.

330.020 INSPECTION AND TESTS ON SITE

A. Visual Inspection: Check neatness of installation, uniformity of equipment and nameplates etc.

B. Illumination Measurements: Taken at selected locations, to determine level and uniformity.

C. Operation: Check lighting installations for operation including control and regulation equipment.

D. Electrical Data: Measure power factor, current and voltage at start for installations with discharge lamps.

E. Inspect each installed fixture for damage. Replace damaged fixtures and components.

F. Advance Notice: Give dates and times for field tests.

G. Provide instruments to make and record test results.

H. Tests: As follows:

1. Verify normal operation of each fixture after installation.
2. Emergency Lighting: Interrupt electrical supply to demonstrate proper operation.
3. Verify normal transfer to battery source and retransfer to normal.
4. Report results in writing.

I. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

J. Corrosive Fixtures: Replace during warranty period.

330.030 CLEANING

A. Clean fixtures internally and externally after installation. Use methods and materials recommended by manufacturer.

330.040 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable fixtures to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.

1. Adjust aimable fixtures to provide required light intensities.

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V23 - LIGHTING CONTROL DEVICES

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. This Section includes time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

110.000 SYSTEM DESCRIPTION

110.010 GENERAL LIGHTING CONTROL DEVICE REQUIREMENTS

A. Line-Voltage Surge Protection: Include in all line voltage solid-state equipment.

110.020 TIME SWITCHES

A. Description: Solid-state programmable units with alphanumeric display.

B. Description: Electromechanical-dial type.

1. Astronomic dial.
2. Two contacts, rated 30-A unless otherwise indicated.
3. Two pilot-duty contacts, rated 2-A unless otherwise indicated.
4. Eight-day program uniquely programmable for each weekday and holidays.
5. Skip-day mode.

110.030 PHOTOELECTRIC RELAYS

A. Description: Solid state, with single-pole, double-throw dry contacts rated to operate connected relay or contactor coils or microprocessor input.

B. Light-Level Monitoring Range: 0 to 37 673 lx, with an adjustment for turn-on/turn-off levels.

C. Time Delay: Prevents false operation.

D. Indoor Ceiling- or Wall-Mounting Units: Adjustable for turn-on/turn-off levels, semiflush, calibrated to detect adequacy of daylighting in perimeter locations, and arranged to turn artificial illumination on and off to suit varying intensities of available daylighting.

E. Indoor Skylight Units: Housed in a threaded plastic fitting for mounting under skylight.

F. Outdoor Sealed Units: Weathertight housing, resistant to high temperatures and equipped with sun-glare shield and ice preventer.

110.040 OCCUPANCY SENSORS

A. Ceiling-Mounting Units: Unit receives control power from a separately mounted auxiliary power and control unit, and operates power-switching contacts in that unit.

B. Ceiling-Mounting Units: Unit receives 24-V dc power from a remote source and, on sensing occupancy, closes contacts that provide signal input to a remote microprocessor-based lighting control system.

C. Switch-Box-Mounting Units: Unit receives power directly from switch leg of the live ac circuit it controls and operates integral power switching contacts rated 1000 W at ac, minimum.

D. Operation: Turns lights on when room or covered area is occupied and off when unoccupied, unless otherwise indicated.

1. Time Delay for Turning Lights Off: Adjustable over a range from 1 to 15 minutes, minimum.
2. Manual Override Switch: Turns lights off manually regardless of elapsed time delay.

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3. Ambient-Light-Level Control: Adjustable for setting a level of ambient illumination above which sensor will not turn lights on when occupancy is sensed.
4. Isolated Relay Contact: Operates on detection of occupancy or vacancy, as indicated, to activate an independent function.

E. Auxiliary Power and Control Units: As follows:

1. Relays rated for a minimum of 20-A normal ballast load.
2. Sensor Power Supply: Rated to supply the number of connected sensors.

F. Passive-Infrared Type: Detects occupancy by a combination of heat and movement in zone of coverage. Each sensor detects occupancy anywhere in an area of 93 sq. m by detecting occurrence of 150-mm minimum movement of any portion of a human body that presents a minimum target of 232 sq. cm to the sensor.

G. Ultrasonic Type: Emits a beam of ultrasonic energy and detects occupancy through use of Doppler's principle in discerning movement in zone of coverage by sensing a change in pattern of reflected ultrasonic energy.

H. Dual-Technology Type: Uses a combination of passive-infrared and ultrasonic detection methods to distinguish between occupied and unoccupied conditions for area covered. Particular technology or combination of technologies that controls each function (on or off) is selectable in the field by operating controls on unit.

110.050 MULTIPOLE CONTACTORS AND RELAYS

A. Description: Electrically operated and mechanically held.

1. Current Rating for Switching: Consistent with type of load served.
2. Control Coil Voltage: Match control power source.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and Division 1 Specification Sections, apply to this Section.

210.000 RELATED SECTIONS

1. Division V Section "Basic Electrical Materials and Methods".
2. Division V Section "Lighting Control Devices" for low-voltage, manual and programmable lighting control systems.
3. Division V Section "Wiring Devices" for wall-box dimmers and manual light switches.

PART 3 PRODUCTS AND WORKMANSHIP

300.000 MATERIALS

300.010 MANUFACTURERS

A. Approved Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

1. Contactors and Relays:

a) Automatic Switch Co. (ASCO)/Emerson Electric
b) Challenger Electrical Equipment Corp.
c) Cutler-Hammer /Eaton Corporation
d) Siemens-Furnas Controls
e) GE Lighting Controls
f) Hubbell Lighting, Inc.

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g) Siemens Energy and Automation, Inc.
h) Schneider Electric
i) Schneider Electric / Square D
j) GE/Zenith Controls, Inc.
k) ABB

2. Time Switches:

a) Diversified Electronics, Inc.
b) Grasslin Controls Corp.
c) Intermatic, Inc.
d) Leviton Manufacturing.
e) Paragon Electric Co., Inc.
f) Tork, Inc.
g) GE/Zenith Controls, Inc.

3. Photoelectric Relays:

a) Allen-Bradley/Rockwell Automation.
b) Area Lighting Research, Inc./Tyco Inc.
c) Fisher Pierce.
d) Grasslin Controls, Corp.
e) Intermatic, Inc.
f) Paragon Electric Co., Inc.
g) M H Rhodes/Cranes Co.
h) SSAC, Inc.
i) Tork, Inc.

4. Occupancy Sensors:

a) Arrow Hart Wiring Devices.
b) BRK Electronics.
c) Bryant Electric.
d) Honeywell, Inc.; Home and Building Controls.
e) Hubbell Lighting, Inc.
f) Lightolier.
g) Lithonia Control Systems.
h) MyTech Corporation.
i) Novitas, Inc.
j) RAB Electric Manufacturing Co., Inc.
k) SenTec, Inc.
l) Sterner Lighting Systems, Inc.
m) Tork, Inc.
n) Touch-plate Lighting Inc..
o) Unenco Electronics (A Hubbell Co.).
p) Watt Stopper, Inc. / Legrand.

300.020 PRODUCTS

A. Products: Subject to compliance with requirements, provide one of the products indicated for each designation as shown on plans.

310.000 QUALITY MANAGEMENT

310.010 QUALITY ASSURANCE

A. Source Limitations: Obtain lighting control devices from a single source with total responsibility for compatibility of lighting control system components specified in this Section, in Division V Section "Lighting Controls Devices,".

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310.020 COORDINATION

A. Coordinate features of devices specified in this Section with systems and components specified in other Sections to form an integrated system of compatible components. Match components and interconnections for optimum performance of specified functions. Include coordination with the following:

1. Division V Section "Network Lighting Controls."
2. Division Y Section "Panelboards."

320.000 SUBMITTALS

A. Product Data: Include dimensions and data on features, components, and ratings for lighting control devices.

B. Samples: Occupancy sensors for color selection and evaluation of technical features.

C. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

D. Maintenance Data: For lighting control devices to include in maintenance manuals specified in Division 1.

330.000 EXECUTION

330.010 INSTALLATION

A. Install equipment level and plumb and according to manufacturer's written instructions.

B. Mount lighting control devices according to manufacturer's written instructions and requirements in Division V Section "Basic Electrical Materials and Methods."

C. Mounting heights indicated are to bottom of unit for suspended devices and to center of unit for wall-mounting devices.

330.020 CONTROL WIRING INSTALLATION

A. Install wiring between sensing and control devices according to manufacturer's written instructions and as specified in Division Y Section "Low Voltage Electrical Power Conductors And Cables" for low-voltage connections and Division 27 Sections related to digital circuits.

B. Wiring Method: Install all wiring in raceway as specified in Division Y Section "Raceways And Boxes For Electrical Systems."

C. Wiring Method: Install all wiring in raceway as specified in Division 26 Section " Raceways And Boxes For Electrical Systems," unless run in accessible ceiling space and gypsum board partitions.

D. Bundle, train, and support wiring in enclosures.

E. Ground equipment.

F. Connections: Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

330.030 IDENTIFICATION

A. Identify components and power and control wiring according to Division V Section "Basic Electrical Materials and Methods."

330.040 FIELD QUALITY CONTROL

A. Schedule visual and mechanical inspections and electrical tests with at least seven days' advance notice.

B. Inspect control components for defects and physical damage, testing laboratory labeling, and nameplate compliance with the Contract Documents.

C. Verify settings of photoelectric devices with photometer calibrated within previous six months.

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D. Electrical Tests: Use particular caution when testing devices containing solid-state components. Perform the following according to manufacturer's written instructions:

1. Continuity tests of circuits.
2. Operational Tests: Set and operate devices to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.

a) Include testing of devices under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.

E. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

F. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

330.050 CLEANING

A. Cleaning: Clean equipment and devices internally and externally using methods and materials recommended by manufacturers, and repair damaged finishes.

330.060 DEMONSTRATION

A. Train Employer's maintenance personnel to adjust, operate, and maintain the system installation. Refer to Division A Section "Demonstration and Training and Closeout Procedures."
1.

330.070 ON-SITE ASSISTANCE

A. Occupancy Adjustments: Within one year of date of Substantial Completion, provide up to three Project site visits, when requested, to adjust light levels, make program changes, and adjust sensors and controls to suit actual conditions.

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V24 - DIMMING CONTROLS

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. This Section includes the following:

1. Integrated, multipreset, modular dimming controls.
2. Multichannel, remote-controlled dimmers.
3. Remote-controlled dimming stations.

110.000 SYSTEM DESCRIPTION

110.010 GENERAL DIMMING DEVICE REQUIREMENTS

A. Line-Voltage Surge Protection: Include in all solid-state equipment.

B. Compatibility: Dimming control components shall be compatible with other elements of interconnected lighting controls and with connected loads as to communication, signaling, and control functions.

C. Dimmers and Dimmer Modules:

1. Audible Noise and Radio-Frequency Interference Suppression: Solid-state dimmers shall operate smoothly over their operating ranges without audible lamp or dimmer noise or radio-frequency interference at any setting. Modules shall include integral or external filters to suppress audible noise and radio-frequency interference.
2. Dimmer or Dimmer-Module Rating: As indicated, but not less than 125 percent of connected load.

D. Panic Switch: Include where indicated or required by authorities having jurisdiction. Switch operation overrides dimmer settings and restores lights on connected output circuits to full brightness regardless of settings.

110.020 MANUAL, MODULAR DIMMING CONTROLS

A. Description: Factory-fabricated equipment providing one to four channels of manual dimming control. Integrate controls and dimmers for mounting in a two- or three-gang wall box under a single wall plate.

B. Module Dimming Capability: Listed for control of type of lighting unit used.

1. Fluorescent Dimmers, 230-V Circuits: Control lights smoothly over a minimum range of 100 to 5 percent of full brightness.
2. Unit Rating: 1900 W, minimum; with each dimming channel rated 600 W, minimum.
3. Wall-Plate Style and Finish: Coordinated with lighting controls specified in other Division V, X and Y Sections.

110.030 INTEGRATED, MULTIPRESET, MODULAR DIMMING CONTROLS

A. Description: Microprocessor-based, solid-state controls.

1. Operation: Automatically changes variable dimmer settings of different groups of lights (channels) simultaneously from one preset scene to another when a push button is operated.
2. Each system includes a control panel and one to four dimmer-control modules. Panels and modules are integrally flush mounted in a single wall box.

B. Control panel adjusts each dimmer channel setting for each scene and commands change from one preset scene to another. Control positions or displays at control panel indicate dimmer settings for each channel for each scene.

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C. Timed cross-fade action occurs when one preset scene is switched to another.

110.040 MULTICHANNEL, REMOTE-CONTROLLED DIMMERS

A. Description: Microprocessor-based, solid-state controls and low-voltage control signals change dimmer settings of remote dimmer modules.

1. Operation: Dimmer modules change intensities of different groups of lights (channels) from one preset scene to another.
2. System includes modular dimmer cabinets and separately mounted control panels.

B. Control panels adjust dimmer channel settings for each scene and command change from one preset scene to another. Displays at control panel indicate dimmer settings for each channel for each scene. Panels are flush mounted with push button and display units and have finish colors as selected by Engineer.

C. Change from one preset scene to another is accomplished by a timed cross-fade action, adjustable over a range of at least 1 to 240 seconds, and is separately programmable for each preset.

D. Dimmer Cabinet: Factory wired and convection cooled without fans.

E. Dimmer Modules: Plug-in type, automatically disconnected by an air-gap relay when switched off or set to minimum intensity. Units withstand power-line surges of 6000 V, 3000 A.

F. Non-dim modules include relays with contacts rated to switch 15-A tungsten filament load and 15-A electronic ballast load.

G. Filtering of each dimmed circuit provides a minimum 350-microsecond current rise time at a 90-degree conduction angle at 50 percent rated dimmer capacity. At any load within rating, rate of current rise does not exceed 30 mA/microsecond, measured from 10 to 90 percent of load current waveform.

H. System Power-Failure Memory Feature: Retain programming for a minimum of 90 days after power failure. When power is restored, return intensities of dimmed lights for each scene to levels set before failure.

110.050 LOW-VOLTAGE WIRING

A. Digital and Multiplexed Signal Wire: Shielded, twisted-pair cable as specified in Division W Sections .

B. Low-Voltage Control Cable: Multiple conductor, color-coded, No. 20 AWG copper, minimum.

1. Sheath: PVC, except in plenum-type spaces use sheath listed for plenums.
2. Ordinary Switch Circuits: Three conductors, unless otherwise indicated.
3. Switch Circuits with Pilot Lights or Locator Feature: Five conductors, unless otherwise indicated.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and Division 1 Specification Sections, apply to this Section.

210.000 RELATED SECTIONS

A. Division V25 Section "Network Lighting Controls" for low-voltage, manual and programmable lighting control systems.

B. Division V Section "Basic Electrical Materials and Methods".

C. Division V Section "Wiring Devices" for wall-box dimmers and manual light switches.

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D. Division V Section "Lighting Control Devices" for time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

PART 1 PRODUCTS AND WORKMANSHIP

100.000 MATERIALS

100.010 PRODUCTS

A. Products: Subject to compliance with requirements, provide one of the products indicated for each designation as shown on plans.

110.000 QUALITY MANAGEMENT

110.010 QUALITY ASSURANCE

A. Source Limitations: Obtain dimming controls from a single source with total responsibility for compatibility of lighting control system components specified in this Section, in Division V Section "Network Lighting Controls," and in Division V Section "Lighting Control Devices."

110.020 COORDINATION

A. Coordinate features of devices specified in this Section with systems and components specified in other Sections to form an integrated system of compatible components. Match components and interconnections for optimum performance of specified functions. Include coordination with the following:

1. Division V Section "Lighting Controls."
2. Division V Section "Lighting Control Devices."

110.030 SPARE PARTS AND EXTRA MATERIAL

A. Furnish extra products described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra products to Employer.

1. Dimmer Modules: 1 for every 10 of each type and rating installed. Furnish at least one of each type.

120.000 SUBMITTALS

A. Product Data: Include dimensions and data on features, components, and ratings for dimming controls. Include elevation views of front panels of control and indicating devices and control stations. Also include the following:

1. List of ballasts and lamp combinations compatible with dimmer controls, by manufacturer and catalog number.
2. Sound data, including results of operational tests of dimming controls.
3. Operational documentation for software and firmware.

B. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on Project. Indicate dimensions, weights, arrangement of components, and clearance and access requirements.

1. Wiring Diagrams: Detail specific systems tailored to this Project and differentiate between manufacturer-installed and field-installed wiring.

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C. Samples: Flush-mounted, dimming control station faceplates for color selection and evaluation of technical features.

D. Manufacturer Certificates: Signed by manufacturers certifying that they comply with requirements.

E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

F. Maintenance Data: For dimming controls to include in maintenance manuals specified in Division 1. Include software operating manuals.

130.000 EXECUTION

130.010 INSTALLATION

A. Install equipment level and plumb and according to manufacturer's written instructions.

B. Mount control equipment according to manufacturer's written instructions and requirements in Division V Section "Basic Electrical Materials and Methods."

C. Mounting heights indicated are to bottom of unit for suspended items and to center of unit for wall-mounting items.

130.020 CONTROL WIRING INSTALLATION

A. Install wiring as specified in Division V Section "Low Voltage Electrical Power Conductors And Cables" for low-voltage connections and Division W Section "Data Communications" for digital circuits.

B. Wiring Method: Install all wiring in raceway as specified in Division Y Section "Raceways And Boxes For Electrical Systems."

C. Wiring Method: Install all wiring in raceway as specified in Division Y Section "Raceways And Boxes," unless run in accessible ceiling space and gypsum board partitions.

D. Bundle, train, and support wiring in enclosures.

E. Ground equipment.

F. Connections: Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in relevant standards.

130.030 IDENTIFICATION

A. Identify components and power and control wiring according to Division V Section "Basic Electrical Materials and Methods."

B. Label each system control module and each remote dimmer bank with a unique designation. Make designations on elevated components readable from floor.

130.040 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: Engage a factory-authorized service representative to test, adjust, and program dimming controls.

B. Schedule visual and mechanical inspections and electrical tests with at least seven days' advance notice.

C. Inspect control components for defects and physical damage, and nameplate compliance with the Contract Documents.

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D. Check tightness of electrical connections with torque wrench calibrated within previous six months. Use manufacturer's recommended torque values.

E. Verify settings of photoelectric devices with photometer calibrated within previous six months.

F. Electrical Tests: Use particular caution when testing devices containing solid-state components. Perform the following according to manufacturer's written instructions:

1. Continuity tests of circuits.
2. Operational Tests: Set and operate controls to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.

a) Include testing of dimming control equipment under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.

G. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

H. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and representative.

I. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

130.050 CLEANING

A. Cleaning: Clean equipment and devices internally and externally using methods and materials recommended by manufacturers, and repair damaged finishes.

130.060 DEMONSTRATION

A. Train Employer's maintenance personnel to adjust, operate, and maintain the system installation. Refer to Division A Section "Demonstration and Training and Closeout Procedures."

130.070 ON-SITE ASSISTANCE

A. Occupancy Adjustments: Within one year of date of Substantial Completion, provide up to three Project site visits, when requested, to adjust light levels, make preset scene changes, and adjust controls to suit actual conditions.

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V25 - NETWORK LIGHTING CONTROLS

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. This Section includes manual, low-voltage lighting controls.

B. This Section includes manual and programmable, low-voltage lighting controls.

C. This Section includes programmable, low-voltage lighting controls.

D. Lighting control devices in compatibility with network lighting control system.

E. Connection to BMS system, including interface elements such as software protocol, relays, transducers, etc., as detailed in Division W Sections and BMS schedules, and shown on Drawings.

110.000 SYSTEM DESCRIPTION

110.010 GENERAL REQUIREMENTS

A. Expansion Capability of System: Adequate to increase the number of control functions in the future by 25 percent more than those indicated. This applies to equipment ratings, housing volumes, spare relays, terminals, and control cable conductor quantities.

B. Line-Voltage Surge Protection: Include in all line voltage solid-state equipment.

110.020 FUNCTIONAL SYSTEM DESCRIPTION

A. A control signal from a manual switch, an internal timing and control unit, or an external sensor or other control signal source is routed to the system control module. This module processes signal according to its programming and routes an "open" or "close" command to one or more relays in the power-supply circuits to groups of lighting fixtures or other loads.

110.030 SYSTEM COMPONENTS

A. Control Module Description: Microprocessor-based, solid-state, 365-day timing unit. Output circuits are switched on or off by internally programmed time signals or by program-controlled analog or digital signals from external sources. Output circuits are pilot-duty relay type capable of operating the types of power switching devices specified. An integral keypad provides local programming and control capability. Keypad use is protected by a key-locked cover and a programmed security access code. An integral alphanumeric liquid crystal or light-emitting-diode display provides menu-assisted programming and control capability. Modules and their associated control panels include the following features:

B. Control Module Description: Microprocessor-based, solid-state, 365-day timing and control unit. Unit is programmable for control of indicated number of output circuits. Output circuits are switched on or off by internally programmed time signals or by program-controlled analog or digital signals from external sources. Output circuits are pilot-duty relay type capable of operating latching-type single-pole lighting circuit relays, multipole lighting contactors, and other devices, all located in other enclosures. An integral keypad provides local programming and control capability. Keypad use is protected by a key-locked cover and a programmed security access code. Manual control and programming steps are viewed on an alphanumeric display. Modules and their associated control panels include the following features:

C. Control Module Description: Microprocessor-based control unit receives programming from hand-held programmer. Control units include a solid-state, programmable, 365-day timing unit and can receive inputs from indicated sensors and other sources. Output circuits are pilot-duty relay type capable of operating latching-type single-pole lighting circuit relays, multipole lighting contactors,

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and other devices. Output circuits also include digital circuits arranged to transmit control commands to remote preset dimmers. Modules and their associated control panels include the following features:

D. Control Module Description: Panelboard mounted, microprocessor based. Panelboard uses low-voltage-controlled, electrically operated, molded-case branch circuit breakers as prime power-circuit switching devices. Circuit breakers and a limited number of digital or analog, low-voltage control circuit outputs are individually controlled by control module. Control unit includes a solid-state, programmable, 365-day timing unit and receives inputs from indicated sensors and other sources. Line-voltage components and wiring are separated from low-voltage components and wiring by barriers. Control module is locally programmable. Panelboard complies with requirements in this Section and in Division Y Section "Panelboards." Modules and their associated control panels include the following features:

E. Control Module Description: Programmable, microprocessor-based control unit mounted in preassembled modular relay panel. Low-voltage-controlled, latching-type, single-pole lighting circuit relays are prime output circuit devices. Where indicated, a limited number of digital or analog, low-voltage control circuit outputs are supported by control unit and circuit boards associated with relays. Control unit receives inputs from indicated sensors and other sources. Line-voltage components and wiring are separated from low-voltage components and wiring by barriers. Control module is locally programmable. Modules and their associated control panels include the following features:

1. System Memory: Nonvolatile. Reboots program and resets time automatically without errors after power outages up to 90 days' duration.
2. Automatic Time Adjustment: System automatically adjusts for leap year and daylight saving time and provides weekly routine and annual holiday scheduling.
3. Astronomic Control: Automatic adjustment of dawn and dusk switching.
4. Remote Communications Capability: Allows programming, data-gathering interrogation, status display, and controlled command override from an IBM-compatible microcomputer at a remote location over telephone or data lines. System includes modem, communications and control software, and remote computer compatibility verification for this purpose. Microcomputer is not in this Contract.
5. Telephone Override Capability: Overrides programmed lighting shutdown commands by telephoning computer and entering a voice-menu-guided override touch-tone code specific to the zone being controlled.
6. Local Override Capability: Manual, low-voltage control devices override programmed shutdown of lighting and override other programmed control for intervals that may be duration programmed.
7. Automatic battery backup provides power to maintain program and system clock operation for 90 days' minimum duration when power is off.
8. Daylight Balancing Dimming Control: Control module interprets variable analog signal from photoelectric sensor and routes dimming signals to dimming fluorescent ballast control circuits. Signal controls dimming of fixture so illumination level remains constant as daylight contribution varies.
9. Daylight Compensating Switch Control: Control module interprets a preset threshold illumination-level signal from a photoelectric relay and activates relays controlling power to selected groups of lighting fixtures to turn them on and off to maintain adjustable minimum illumination level as daylight contribution varies.
10. Flick Warning: Programmable momentary turnoff of lights warns that programmed shutoff will occur after a preset interval. Warning is repeated after a second preset interval before end of programmed override period.
11. Diagnostics: When system operates improperly, software initiates factory-programmed diagnosis of failure and displays messages identifying problem and possible causes.

F. Mechanically Held, Modular Single-Pole Relays: Split-coil, momentary-pulsed type.

1. Low-Voltage Leads: Five-pin plug connector.
2. Pilot Contacts: Single pole.
3. Rated Capacity (Mounted in Relay Panel): 20 A for tungsten filaments; and 20 A for ballasts.

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4. Endurance: 50,000 cycles at rated capacity.
5. Mounting: Knockout in modular relay panel, unless otherwise indicated.

G. Electrically Held, Modular Single-Pole Relays: As follows:

1. Rated Capacity (Mounted in Relay Panel): 20 A for all types of fluorescent and HID ballasts; and 15 A for tungsten filaments.
2. Operating Coil: DC.
3. Mounting: Modular printed circuit board. Board is held in place in modular relay panel by quick-release spring pins, unless otherwise indicated.
4. Pilot Device: Provides positive relay position indication.

H. Modular Relay Panels: Steel cabinets, preassembled with modular single-pole relays, power supplies, and accessory components required for specified performance.

1. Barriers separate low-voltage and line-voltage components.
2. Cover: Hinged, lockable type.
3. Directory: Mounted on back of door. Identifies each relay as to bunch loads controlled, and each programmed pilot device, if any.
4. Control Power Supply: Transformer and full-wave rectifier with filtered dc output.

I. Time Switches: Solid-state programmable units with alphanumeric display and shall be compatible with the network lighting control system used.

J. Photoelectric Relays: Solid state, with single-pole, double-throw dry contacts rated to operate microprocessor input, compatible with the network lighting control system used and shall have the following features:

1. Light-Level Monitoring Range: 0 to 37 673 lx, with an adjustment for turn-on/turn-off levels.
2. Time Delay: Prevents false operation.
3. Indoor Ceiling- or Wall-Mounting Units: Adjustable for turn-on/turn-off levels, semiflush, calibrated to detect adequacy of daylighting in perimeter locations, and arranged to turn artificial illumination on and off to suit varying intensities of available daylighting.
4. Indoor Skylight Units: Housed in a threaded plastic fitting for mounting under skylight.
5. Outdoor Sealed Units: Weathertight housing, resistant to high temperatures and equipped with sun-glare shield and ice preventer.

K. Occupancy Sensors: Compatible with the lighting control system used and with the following features

1. Ceiling-Mounting Units: Unit receives 24-V dc power from a remote source and, on sensing occupancy, closes contacts that provide signal input to a remote microprocessor-based lighting control system.
2. Switch-Box-Mounting Units: Unit receives power directly from switch leg of the live ac circuit it controls and operates integral power switching contacts rated 1000 W at ac, minimum.
3. Operation: Turns lights on when room or covered area is occupied and off when unoccupied, unless otherwise indicated.

a) Time Delay for Turning Lights Off: Adjustable over a range from 1 to 15 minutes, minimum.
b) Manual Override Switch: Turns lights off manually regardless of elapsed time delay.
c) Ambient-Light-Level Control: Adjustable for setting a level of ambient illumination above which sensor will not turn lights on when occupancy is sensed.
d) Isolated Relay Contact: Operates on detection of occupancy or vacancy, as indicated, to activate an independent function.

L. Auxiliary Power and Control Units: As follows:

1. Relays rated for a minimum of 20-A normal ballast load or 13-A tungsten filament or high-inrush ballast load.
2. Sensor Power Supply: Rated to supply the number of connected sensors.

a) Passive-Infrared Type: Detects occupancy by a combination of heat and movement in zone of coverage. Each sensor detects occupancy anywhere in an area of 93 sq. m by detecting

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occurrence of 150-mm minimum movement of any portion of a human body that presents a minimum target of 232 sq. cm to the sensor.

b) Ultrasonic Type: Emits a beam of ultrasonic energy and detects occupancy through use of Doppler's principle in discerning movement in zone of coverage by sensing a change in pattern of reflected ultrasonic energy.

c) Dual-Technology Type: Uses a combination of passive-infrared and ultrasonic detection methods to distinguish between occupied and unoccupied conditions for area covered. Particular technology or combination of technologies that controls each function (on or off) is selectable in the field by operating controls on unit.

3. Multipole Contactors and Relays: Electrically operated and mechanically held, compatible with the lighting control system used and shall have the following features:.

a) Current Rating for Switching: Consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballasts with 15 percent or less total harmonic distortion of normal load current).

b) Control Coil Voltage: Match control power source.

M. MANUAL SWITCHES AND PLATES

1. Switches: Modular, momentary push-button, low-voltage type.

a) Color: White, unless otherwise indicated.

b) Integral Pilot Light: Indicates when circuit is on.

c) Locator Light: Internal illumination helps locate switch in the dark.

d) Wall Plates: Match those specified in Division V Section "Wiring Devices" to materials, finish, and color. Use multigang plates if more than one switch is indicated at a location.

e) Legend: Engraved or permanently silk-screened on wall plate where indicated.

N. LOW-VOLTAGE WIRING

1. Digital and Multiplexed Signal Wire: Shielded, twisted-pair cable as specified in Division W Section "Data Communications."

2. Low-Voltage Control Cable: Multiple conductor, color-coded, 0.6 mm2 copper, minimum.

a) Sheath: PVC, except in plenum-type spaces use sheath listed for plenums.

b) Ordinary Switch Circuits: Three conductors, unless otherwise indicated.

c) Switch Circuits with Pilot Lights or Locator Feature: Five conductors, unless otherwise indicated.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and Division A Specification Sections, apply to this Section.

210.000 RELATED SECTIONS

A. Related Sections include the following:

1. Division V Section "Basic Electrical Materials and Methods".
2. Division V Section "Wiring Devices" for wall-box dimmers and manual light switches.
3. Division V Section "Dimming Controls" for architectural dimming system equipment.

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PART 3 PRODUCTS AND WORKMANSHIP

300.000 MATERIALS

300.010 MANUFACTURERS

A. Approved Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

1. Crestron Electronics, Inc.
2. Cutler-Hammer/Eaton Corporation.
3. GE Lighting Controls.
4. Honeywell, Inc./Home and Building Controls.
5. Johnson Controls, Inc./Controls Group Div.
6. Lutron Electronics Co., Inc.
7. Schneider Electric
8. Schneider Electric / Square D Co.
9. ABB

310.000 QUALITY MANAGEMENT

310.010 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is an authorized representative of the programmable lighting system manufacturer for both installation and maintenance of units required for this Project.

B. Manufacturer Qualifications: A firm experienced in manufacturing programmable lighting controls similar to those indicated for this Project and with a record of successful in-service performance.

C. Source Limitations: Obtain low-voltage lighting control system components from a single manufacturer.

1. Provide total responsibility for compatibility of system components, including those provided in this Section and in Division V Sections "Lighting Control Devices" and "Dimming Controls."

310.020 SPARE PARTS AND EXTRA MATERIAL

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Employer.

1. Modular Single-Pole Relays: 1 for every 10 installed. Furnish at least one of each type.
2. Electrically Operated, Molded-Case Circuit Breakers: 1 for every 20 of each type and rating installed. Furnish at least one of each type.

320.000 SUBMITTALS

A. Product Data: Include dimensions and data on features, components, and ratings for lighting controls.

B. Shop Drawings: Detail assemblies of standard components, custom assembled for specific application on Project. Indicate dimensions, weights, arrangement of components, and clearance and access requirements.

1. Wiring Diagrams: Detail specific systems tailored to this Project and differentiate between manufacturer-installed and field-installed wiring.

C. Operational Documentation: For software and firmware.

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D. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects/engineers and owners, and other information specified or required by Engineer.

E. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

F. Maintenance Data: For lighting control equipment and system components to include in maintenance manuals specified in Division A. Include software-operating manuals.

320.020 COORDINATION

A. Coordinate features of equipment and system components to form an integrated system of compatible components. Match components and interconnections for optimum performance of specified functions.

B. Coordinate lighting controls specified in this Section with work specified in other Sections, including the following:

1. Division V Section "Lighting Control Devices."
2. Division Y Section "Panelboards."
3. Division V Section "Dimming Controls."

320.030 INSTALLATION

A. Install equipment level and plumb and according to manufacturer's written instructions.

B. Mount control equipment according to manufacturer's written instructions and requirements in Division V Section "Basic Electrical Materials and Methods."

C. Mounting heights indicated are to bottom of unit for suspended items and to center of unit for wall-mounting items.

320.040 CONTROL WIRING INSTALLATION

A. Install wiring between control devices as specified in Division Y Section "Low Voltage Electrical Power Conductors and Cables" for low-voltage connections and Division W Section "Data Communications" for digital circuits.

B. Wiring Method: Install all wiring in raceway as specified in Division Y Section "Raceways and Boxes."

C. Bundle, train, and support wiring in enclosures.

D. Ground equipment.

E. Connections: Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A – UL 486 B.

320.050 IDENTIFICATION

A. Identify components and power and control wiring according to Division V Section "Basic Electrical Materials and Methods."

B. Label each system control module with a unique designation. Make designations on elevated components readable from floor.

320.060 FIELD QUALITY CONTROL

A. Schedule visual and mechanical inspections and electrical tests with at least seven days' advance notice.

B. Electrical Tests: Use particular caution when testing devices containing solid-state components. Perform the following according to manufacturer's written instructions:

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1. Continuity tests of circuits.
2. Operational Tests: Set and operate controls to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.

    a) Where light balancing or other control involving equipment provided under other Sections is indicated, combine testing required by this Section with that required by Sections specifying other equipment. Test programmable control related to light balancing, occupancy sensing, and other controls under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.

C. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.

D. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

320.070 CLEANING

A. Cleaning: Clean equipment and devices internally and externally using methods and materials recommended by manufacturers, and repair damaged finishes.

320.080 ON-SITE ASSISTANCE

A. Occupancy Adjustments: Within one year of date of Substantial Completion, provide up to three Project site visits, when requested, to adjust light levels, make program changes, and adjust sensors and controls to suit actual conditions.

320.090 DEMONSTRATION

A. Explain programming and operation of system and train Employer's maintenance personnel on procedures and schedules for maintaining, programming, operating, adjusting, troubleshooting, and servicing system. Refer to Division A Section "Demonstration and Training and Closeout Procedures."

    1. Provide a minimum of eight hours' training in operation and maintenance.

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V32 – STATIC UNINTERRUPTIBLE POWER SUPPLY

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. This Section includes, on-line, static-type, continuous duty, solid state, double conversion uninterruptible power supply (UPS) system installation and static transfer switch, comprising the following:

1. Complete rectifier/charger-battery-inverter system with 100% rated for continuous automatic static switch and maintenance manual by-pass switch.
2. Input harmonic filter.
3. Output isolation transformer.
4. Power conditioner.
5. Interplant power and control cabling.
6. Connection of normal AC power from assigned terminals/switch/circuit breaker, as shown on the Drawings.
7. Earthing system.
8. Connection to BMS system for full monitoring, including proper interface digital software link for remote monitoring from BMS for the points specified in this Section and as detailed in BMS schedules and /or shown on the Drawings as a minimum.

110.000 DESIGN PARAMETERS

110.010 PROJECT/SITE CONDITIONS

A. Temperature limits within which equipment shall be designed to operate are zero to +40 deg. C at 100% rated output. Equipment shall be capable of operating under up to 55 deg. C ambient conditions with derating factor of 1.25% per deg. C over 40 deg. C.

110.020 DEFINITIONS AND ABBREVIATIONS

A. EMI: Electromagnetic interference.

B. LCD: Liquid-crystal display.

C. LED: Light-emitting diode.

D. UPS: Uninterruptible power supply.

110.030 REFERENCE STANDARDS

A. Standards: Installation shall comply with the following standards:

1. IEC 62040-1,2&3 “Uninterruptible Power Systems”.
2. IEC 61000-3-4 “Electromagnetic compatibility (EMC) - Part 3-4: Limits - Limitation of emission of harmonic currents in low-voltage power supply systems for equipment with rated current greater than 16 A”.
3. IEC 61000-4 “Electromagnetic compatibility (EMC) – Testing and Measurement Techniques”.
4. IEEE 485 “IEEE Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications”.
5. IEC 62310 “Static Transfer Systems”.
6. IEC 61000-3-2 “Electromagnetic compatibility (EMC) - Part 3-4: Limits - Limitation of emission of harmonic currents in low-voltage power supply systems for equipment with rated current greater than 16 A”.
7. IEC 61000-3-3 “Electromagnetic compatibility (EMC) - Part 3-3: Limits - Limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤16 A per phase and not subject to conditional connection”.

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8. IEC 61000-6-2 “Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments”.
9. IEC 61000-6-3 “Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments”.

120.000 SYSTEM DESCRIPTION

120.010 GENERAL SYSTEM DESCRIPTION

A. System: UPS system shall be online, continuous duty, double conversion, class VFI-SS-111 to IEC 62040-3.

B. System shall be of the programmable type, microprocessor based with CPU and memory capabilities for storage of alarms, faults, status change, etc. The UPS shall permit setting parameters for the environment and type of usage to be specified by the Engineer. UPS shall be of the self-diagnostic type, equipped with a self-test function to verify correct system operation. The self-test shall identify the parts of the UPS requiring repair in case of a fault. The system shall be provided with multi-password levels to limit access to software and data.

C. General: System shall be interposed between normal AC power supply and critical load, to secure a minimum period of continuity of no-break battery back-up for the time shown on Drawings in case of failure of normal AC supply and maintain output voltage, frequency and phase deviation within specified tolerances.

D. Redundant systems may be selected for systems 40 kVA and over, depending on criticality of the supplied load and for high reliable requirements. System shall be 100% fully rated, single, dual or “n+1” multi-unit parallel redundant for number and capacity as shown on drawings; which implies complete UPS unit(s) with two sets of battery strings operating in parallel for each unit for ratings up to 80 kVA and two to four sets of battery strings in parallel for each unit for ratings above 80 kVA unless otherwise recommended by the manufacturer and approved by the Engineer. UPS shall be maintained (continuously supplying load through the inverter), with automatic no-break transfer to or retransfer from alternate source (bypass) in case of failure or overload on rectifier- battery-inverter system. System shall employ decentralized bypass technique so that each UPS unit shall be provided with its own static bypass transfer switch. Each UPS unit shall be provided with its own master controller. Master and slave configuration is not acceptable.

E. Normal AC power supply will be available from one protected source fed from either normal AC network or from AC Characteristics of output of generator set (when provided) and UPS system shall be coordinated for best results. Study and advise on special requirements of generator characteristic output and stability.

F. Redundant Systems: have parallel units interconnected so that normal AC power feeds two or more inverters in parallel, to give required power output at critical load. Load sharing circuits shall ensure real and reactive load sharing and provide reverse power protection between parallel units. Full rated capacity of UPS, in case of failure of one of the rectifiers or one of the inverter units shall be equally shared by other healthy units without overloading these units or disturbing operation.

G. Separate filters shall be provided for each rectifier/charger unit separately to limit the THD to less than 7% this applies for all load currents from 25 to 100% of full load.

H. System overall efficiency shall not be less than [

90 % at full load and 88 % at half load (up to 5kVA system).

92 % at full load and 90 % at half load (10-40kVA system).

93 % at full load and 91 % at half load (60-500kVA system).

I. Noise level of complete assembly shall not exceed the following values at 1.0 m distance anywhere within UPS room.

50 dB(A) for ratings up to 5 kVA

60 dB(A) for ratings up to 20 kVA

65 dB(A) for ratings up to 125 kVA

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70 dB(A) for ratings up to 220 kVA

70-75 dB(A) for ratings up to 500 kVA

120.020 SYSTEM OPERATION

A. Under normal conditions inverter(s) shall be synchronized and phase locked to normal AC supply. Upon loss of normal AC supply, battery shall continue supply of no-break power to inverters, which then free-run on self- generated UPS frequency reference. Upon restoration of normal AC supply, inverters shall re-synchronize to AC line, gradually (at slew rate), if frequency and voltage deviation of normal AC supply is within preset limits specified.

B. Automatic Transfer To Bypass: Static transfer switch shall automatically transfer critical (100%) load from inverter to by-pass source (which is normal AC supply) if:

1. Inverter output voltage characteristics fall outside specified limits.
2. Critical load exceeds overload rating of UPS.
3. Over-temperature is sensed.
4. Manual (push button) command is given.
5. Transfer to by-pass mode shall be inhibited, and an alarm initiated if voltage, frequency and/or phase shift of by- pass power is outside acceptable tolerances.

C. Re-Transfer To Inverter: Re-transfer of critical load from auto by-pass source to inverter (UPS mode) is only to be possible under the following conditions:

1. Inverter output voltage characteristics return to within specified tolerances.
2. Original load current reduces to within rated full load capacity of UPS.
3. Re-transfer selector switch is in automatic position.

D. Lock-out feature shall inhibit re-transfer if by-pass source conditions are outside preset tolerances or if UPS output and by-pass are not synchronized and phase locked or if UPS output is not restored to normal conditions.

E. Normal Power Restored: When normal power is restored following an outage, rectifier/charger shall initially draw no power except for transformer in-rush current and shall gradually continue providing power to the inverter and recharging the battery. After approximately 15 seconds (walk-in time), input power requirements shall rise to power level to drive critical load and recharge battery.

F. Automatic Restart: When normal power is restored to normal conditions following an outage and after a complete battery discharge, the UPS shall automatically restart and resume supplying power to the connected load via the inverter.

G. Provide maintenance disconnecting switch fully rated to carry the full load input current of the UPS.

120.030 SYSTEM CHARACTERISTICS

A. Rectifier/Charger Input:

1. Nominal Input Voltage: 400V, three phase, 4 wire, 50Hz.
2. Voltage input variation: +10%, -15% from nominal.
3. Frequency: +/-5% from nominal.
4. Transformer Exciting Current In Rush: Less than 600 % nominal current.
5. Power Factor: minimum 0.9 lagging at full load and nominal input voltage.
6. Total Feedback Current Harmonics: Maximum **7** % for UPS ratings above 20kVA and 8% for UPS ratings 20kVA and below.
7. Current Limiting: 115% max. of that required to operate inverters and charge battery at full rated load, adjustment possible between 100% and 125%.
8. Walk-in Current in Rush: 25% to 100% FLC in 15 seconds.

B. Rectifier/Charger Output:

1. Float and Equalize Operation: Adjustable, automatic, compatible with battery.
2. Regulation: +/-1% max. from 0-100% load.
3. Ripple: +/-2% rms. (0 to 100% resistive load).
4. Static Inverters:

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5. Nominal net system power output rating in kVA: as shown on drawings with load power factor 0.8 lag.
6. Nominal output voltage: 400 V, three phase, 4 wire, 50 Hz, adjustable +/-5% of nominal.
7. Output voltage regulation:

    a) Balanced load: +/-2% (0 - 100% load)
    b) Unbalanced load (3-phase output only): +/-3% (at each 10% of load)

8. Phase Displacement: 120 deg. (+/-3 deg.) at 100% load unbalance.
9. Output Voltage Waveform: 5% max. total harmonic, 3% max. single harmonic.
10. Frequency Stability: Normally synchronized to input line frequency over +/-2 adjustable ranges; free running at +/-0.5. Full battery voltage variation, load and p.f. range; slew rate shall not exceed 0.1 Hz/sec.
11. Dynamic Output Voltage Tolerance Sudden Full Load Removal: +/-10% max. recovering application or to within 1% in less than 100 milliseconds.
12. Over-load Rating: 125% for 10 minutes, 150% for 60 seconds, 1000% for 5 cycles, 105% continuous.
13. Load crest factor without derating (Ipk/Irms): 3:1

C. Automatic Static Bypass Transfer Switch:

1. Transfer Time: 150 microsecond (overlapping) maximum.
2. Total Sensing and Transfer/Retransfer Time: 2 milliseconds, maximum.
3. Retransfer Mode: automatic/inhibit (selectable).
4. Retransfer Delay: 2 - 32 secs. in auto mode (selectable).
5. Transfer Point: +/-10% of nominal output voltage (adjustable).
6. Retransfer Point: +/-5% of nominal output voltage (adjustable).
7. Transfer Inhibit Point: +/-20% of nominal output voltage (adjustable).
8. Bypass circuit shall be provided with backfeed protection to IEC 62040-1 through internal backfeed contactor to prevent feedback to the mains from the inverter in case of mains failure and a fault in bypass circuit.

120.040 COMPONENTS AND ACCESSORIES

A. Materials and Parts: Electronic devices shall be solid state, hermetically sealed. Indicator lights shall be twin LED type, those denoting blown fuse conditions shall be seen by operator without removing panels or opening cabinet doors. Power connections and remote alarm and control wiring shall be accessible at terminal boards. Power semi- conductors shall be fused. Metal surfaces including copper and aluminium heat sinks and busbars shall be treated with permanent protective coating. Electro-mechanical power devices and relays shall be vacuum impregnated, insulated for maximum operating voltage conditions, and enclosed in dust-tight enclosures. Cables shall be fire resistant high temperature grade.

B. UPS shall be provided with a socket connection for a serial interface to be linked to a portable PC, to a modem or to the BMS system for communication with the UPS. It shall enable interrogation of the UPS about status, faults, data stored, reprogramming, etc.

C. Housing: Equipment shall be housed in a free-standing, well ventilated, totally enclosed modular assembly with front accessible lockable doors, giving easy access for maintenance, inspection and adjustments, and with provisions for handling and lifting during and after installation. Enclosures shall be suitable for industrial, tropical environments, protection IP 21 to IEC 60529, of galvanized sheet steel construction treated against corrosion and with light grey RAL7032 baked paint or epoxy finish to approved standard.

D. Where single core cables are used, top / bottom cable entry plates shall be made of bakelite or Aluminum with adequate thickness and rigidity to support cables.

E. Sub-assemblies and components shall be mounted on pull- out and/or swing-out trays, of the plug-in type where possible. Where it is not possible to mount components in pull-out or swing-out trays, they shall be easily accessible inside the enclosure. Assemblies shall be replaceable without requiring any adjustments or settings in the UPS.

F. Ventilation: For units rated over 3 kVA, an integral, forced-air, cooling system shall be provided in each UPS module to remove dissipated heat efficiently, and ensure components operate within

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environmental ratings. Air shall enter bottom of cabinet through replaceable filters, and exhaust through the top. At least two fans shall be provided for ventilating each enclosure. No degradation of performance shall occur in the event of a single fan failure. Temperature sensors, mounted on semi-conductor heat sinks, shall initiate alarm if maximum working temperature is exceeded.

G. Rectifier/charger unit shall be as follows:

H. Active front end (AFE) Insulated Gate Bipolar Transistor (IGBT) or 6-pulse silicon controlled rectifier (SCR) type for UPS ratings up to 40 kVA.

I. IGBT type UPS ratings 40 kVA and up to 200 kVA.

J. IGBT or 12 pulse SCR type with filter for UPS ratings above 200 kVA.

K. The unit shall have mainline circuit breaker and a rectifier input transformer for 12 pulse UPS, and shall be automatic with soft start-up (walk-in) feature, using IGBT with vector control design or silicon controlled rectifiers (SCR) with control logic circuitry to control firing angles to SCR to suit power output requirements and protect against primary power surges, lightning transients, under-voltage and over-voltage conditions. Output shall be passed through LC filters to DC bus.

L. Rectifier/charger unit shall be microprocessor based and capable of supplying full load power to inverter, and to charge the battery from a discharge condition to 90% charge within ten to twelve hours, and maintain full charge at floating voltage until next operation. The rectifier/battery charger shall employ input AC current limiting as well as battery charge current limiting for battery protection. Charger current shall be voltage regulated and current limited. The control of the optimum charging method shall be completely controlled by the charger's microprocessor.

M. Inverter shall employ IGBT technology in three leg, vector control or high frequency switching and real time control technique, and complete with output transformer and filters. Inverter start-up shall be automatic, to reach full voltage within milliseconds and deliver power to the load within 2 seconds. Inverter shall start at any load including short-circuit. Inverter shall be provided with an inverter output transformer. For UPS ratings 200kVA and below transformer-less technique may be used, subject to Engineer's approval.

N. Inverter oscillator shall operate and maintain output frequency of inverter within specified tolerances, and be capable of synchronization and phase-locking to normal power supply frequency. When inverter is phase-locked to normal power supply, and latter fails, oscillator shall automatically revert to free running state (quartz oscillator) and maintain specified limits.

O. Modular UPS system where shown on the Drawings shall consist of multiple units with equal capacities, each not exceeding 50 kVA, connected in parallel architecture and share one common frame or more according to the required number of modules, each frame shall have common input and output busses and separate battery system consisting of two parallel strings as a minimum. Modular UPS system shall be online, double conversion, IGBT rectifier, IGBT inverter with transformerless technique. The modular UPS system shall have the following features as a minimum:

    1. Each module shall be provided with fully rated static and maintenance bypass.
    2. The modular system shall be expandable by adding modules without shutting down the system (hot pluggable).
    3. Modules shall be replaceable without shutting down the system during the replacement process (hot swappable).
    4. The modular system shall not have a single point of failure. Fault on any of the modules shall not affect the whole system.
    5. Sufficient space for the number modules for future expansion shall be provided as shown on the Drawings.
    6. Redundancy, if required on the Drawings, shall be achieved by adding a number of modules with total power capacity shown on the Drawings.
    7. Battery capacity shall be expandable by adding independent battery strings to cater for the increase in the system power. Adding battery strings shall be done without shutting down the system.

P. Automatic static bybass transfer switch shall be continuously rated at full load (100% FL), hybrid type (make-before-break), solid state transfer device with logic thyristor assembly isolatable or

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completely removable for maintenance. When signal to close switch is initiated, thyristors shall instantaneously conduct power to prevent deviations and breaks in load voltage outside specified tolerances.

Q. Maintenance By-Pass Switching: Manual (make-before- break) by-pass switch shall allow load to be transferred to by-pass source without interruption of output, and provide isolation of UPS and static switch during maintenance. Test position shall permit testing of static switch while load is being fed from bypass power circuit. Transfer inhibited warning circuit shall be provided to give an alarm indication in case by-pass supply is beyond acceptable tolerances.

R. Rectifier input and bypass isolating transformers shall be provided for all UPS ratings 80 kVA and above. Isolating transformer shall be installed on the UPS output if the system is transformer less (without inverter transformer) and on UPS bypass input if the UPS is equipped with inverter transformer.

S. UPS inverter output, IGBT rectifier input and bypass input transformers shall be two-winding type, while 12 pulse rectifier input transformers shall be three winding type.

T. Transformers shall be galvanically isolated dry-type, Class H insulated, with metallic electrostatic shielding, and high efficiency (98% or higher) type. Transformers shall be installed either within the UPS enclosure or in a separate enclosure as applicable and approved by engineer.

U. Protection: UPS modules shall have built-in or inherent electronic current-limiting protection against permanent self damage effective down to short-circuits. Fast acting, current limiting devices shall protect against failure of any solid state component. Internal failure in any UPS module shall cause immediate isolation from input and output by operation of static interrupters or causing shut down of faulty module. Protection shall be provided against, but is not limited to, the following:

1. Input over and under voltage and power line surges
2. Output over voltage and voltage surges
3. Sudden abnormal changes in output load conditions
4. Short-circuits at output terminals
5. Inverter and rectifier overcurrent
6. Auxiliary Control Circuit Overcurrent.

V. UPS Bypass and Output Neutral: Designed to continuously carry twice the full load phase current.

W. Input Passive Filter Disconnection: UPS control system shall not disconnect the input passive filters unless the UPS is operating at light loads (less than 25%).

X. Battery: High rate discharge, heavy duty, industrial, high impact resistant, clear plastic encased, sealed lead- acid (gas recombination) type cells with automatically re-closing explosion proof safety vents. Electrolyte specific gravity shall not exceed 1.25 when fully charged at 25 deg. C. Ampere-hour rating shall be sufficient for emergency period specified with all inverters operating at full rated output, to a discharge limit of not less than 1.75 V per cell. Cells shall be normally maintained at 2.25 V per cell. Guaranteed life shall not be less than 10 years, with a capacity drop down to not less than 80% under normal expected service.

Y. Battery Cabinet: shall be factory assembled from UPS manufacturer, of welded construction and formed from heavy gauge steel with added supports to retain cabinet squareness and integrity during harsh shipping and handling conditions, Adjustable battery rails or trays shall be provided to allow for multiple battery configurations and facilitate battery upgrades in the future, Heavy duty polyester strapping material shall be used to tie down batteries, Cabling shall be routed down the sides of the cabinet, away from the front of the batteries allowing full access for easy maintenance, series wiring shall be routed efficiently and neatly with tier to tier jumpers located at front batteries allowing for safe and easy maintenance, Cabinets shall be top coated with a hybrid epoxy-polyester powder coat and oven cured for a chip and corrosion resistant long lasting finish, All circuit breakers used on the cabinets shall be rated to 600 VDC. Each battery string shall be provided with its own circuit breaker for the individual string fault protection and disconnecting means. Battery cabinet enclosure degree of protection shall be IP 20.

Z. Battery checking system shall be provided for each UPS to check the battery continuity and improve life time through regular automatic test and measurements for battery status, voltage and current. System shall provide a predictive and automatic diagnostics of battery health, optimize the recharge

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time and provide an advance warning about the end of battery life upon detection of a weak / defective battery.

AA. The battery cells age, at the time of delivery into site, shall be less than three months.

BB. Battery calculations according to IEEE 485 shall be carried out by UPS supplier and submitted for approval, based on the following:

1. Nominal active power factor of not less than 0.8 Lag.
2. Temperature factor for operation at 25 Deg C.
3. Aging factor of 1.25.
4. Design margin factor of 1.15.
5. Recharge time up to 90% of its capacity within 10 to 12 hours.

CC. Mimic Panel: UPS assembly shall include a mimic diagram with digital and LED displays, indicating instruments and control devices, in true relative positions.

DD. Local panel instruments shall include at least the following (digital readings):

1. Inverter input voltage: measuring DC bus voltage.
2. Battery current: measuring charge / discharge currents.
3. AC voltage: measuring inverter output voltage, normal supply voltage or system output.
4. UPS output measurements: for current, voltage and frequency.
5. Remaining battery backup time.
6. Input voltages.
7. Input current.
8. Total power.
9. Total harmonic distortion on input feedback current (THDi).
10. Total harmonic distortion on input voltage (THDv).

EE. Local Panel Indicators shall include at least the following:

1. System on battery supply.
2. Inverter phase locked to verify synchronization between inverter output and normal AC supply input.
3. Static switch on normal AC supply (bypass mode).
4. Static switch inhibited.
5. Over-temperature, indicating excessive temperature in heat sinks for transformers, rectifier/charger and inverter (alarm to automatically transfer load to by-pass circuit).
6. Inverter output overload, indicating inverter output beyond specified rating failure of any stage, DC bus earth fault, inverter output earth fault.

FF. Local built-in controls shall include at least the following:

1. Inverter on/off.
2. Battery input circuit breaker.
3. Auto/manual reset-test switch.
4. Manual reset switch.
5. Hybrid switch transfer test push-button.
6. Re-transfer auto/inhibit selector switch to allow automatic re-transfer of load to inverter after timed interval of normal operation and inhibit re-transfer of load to inverter until hybrid switch is in auto-mode.
7. Battery automatic/equalize recharge timer, 0 - 30 hours adjustable, with automatic/boost/equalize switch (accessible to maintenance personnel only and to be used only with manufacturer's recommendation for type of battery specified).
8. Voltage and frequency adjustment controls with locking devices (accessible to maintenance personnel only).
9. Indicator test/reset switch.
10. Control power supply isolator (accessible to maintenance personnel only).
11. Alarm test-accept-reset.

GG. Local built-in alarms causing horn to sound, with tripping command if required, shall include at least the following:

1. Fan failure: Alarm only.

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2. Over Temperature: Alarm with automatic transfer of load to by-pass after a safe preset period.
3. DC Volts out of Limits: Alarm with indication.
4. Fuse Failure: Alarm.
5. Battery on Load/Disconnected: Alarm only.
6. Overloads: Alarm only with a trip command if pro- longed, for each rectifier/inverter unit.
7. Normal AC Supply Failure: Alarm only.
8. Hybrid Switch Operation to by-pass Mode: Alarm only.
9. Low and High Output Voltage: Alarm only.

HH. Input active harmonic filter shall be provided to limit input current harmonic distortion to less than 7% THD at all load currents from 0 to 100% of full load and improve power factor to not less than 0.9. The input filter shall be mounted inside the UPS cabinet or in a separate enclosure.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and Division A Specification Sections, apply to this Section.

210.000 RELATED SECTIONS

A. Division V Section "Basic Electrical Materials and Methods".

B. Division Y Section "Earthing and Bonding ".

C. Division Y Section "Low Voltage Electrical Power Conductors and Cables ".

D. Division W Section "Central Control / Building Management ".

PART 3 PRODUCTS AND WORKMANSHIP

300.000 MATERIALS

300.010 MANUFACTURERS

A. Approved Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

1. Eaton / Powerware
2. GE
3. APC/Schneider Electric
4. Siemens
5. Socomec
6. Emerson – Libert
7. ABB / Newave

300.020 PRODUCTS

A. Products: Subject to compliance with requirements, provide one of the products indicated for each designation as shown on plans.

310.000 QUALITY MANAGEMENT

310.010 QUALITY ASSURANCE

A. Manufacturer’s Certification: The manufacturer shall be specialized in manufacturing of on line, double conversion three phase UPS modules specified in this document with a minimum of twenty years documented worldwide experience and shall have a nationwide first party service organization. The manufacturer shall be ISO 9001 certified and shall design to internationally accepted standard.

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B. Factory Testing: Prior to shipment the manufacturer shall complete a documented test procedure to test all functions of the UPS modules and batteries (via a discharge test), when supplied by the UPS manufacturer and guarantee compliance with the specification. The manufacturer shall provide a copy of the test report upon request. Tests shall comply to IEC 62040-3 and include but not necessarily limited to the following:

1. Light load test.
2. AC input failure test.
3. AC input return test.
4. Transfer test.
5. Full load test.
6. UPS efficiency test.
7. Unbalanced load test.
8. Balanced load test.
9. Short-circuit test.
10. Harmonic components test.

C. Materials and Assemblies: All materials and parts comprising the UPS shall be new, of current manufacture, and have not been in prior service, except as required during factory testing. All active electronic devices shall be solid state and not exceed the manufacturers recommended specified tolerances for temperature or current to ensure maximum reliability. All semiconductor devices shall be sealed. All relays shall be provided with dust covers. The manufacturer shall conduct inspection on incoming parts, modular assemblies, and final products.

D. Installer Qualifications: Experienced installer who is an authorized representative of UPS manufacturer for both installation and maintenance of units required for this Project.

E. Local Representative: Provide evidence that proposed equipment manufacturer has a locally established and authorized organization which can be called upon for professional advice and maintenance as may be required, and which can immediately supply spare parts to support day to day and emergency maintenance requirements. Failure to satisfy Engineer may disqualify a manufacturer.

F. Materials and components shall be manufacturer's latest design, and Standards used shall be approved prior to manufacture.

310.020 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, and handle materials, components, and equipment as per Manufacturer’s instructions.

B. Equipment containing batteries shall not be stored for a period exceeding 3 months without powering up the equipment for a period of 8 hours to recharge the batteries. . Relevant Certificate for the batteries production date shall be submitted to the engineer.

310.030 WARRANTY

A. Manufacturer’s Warranty: Submit a written warranty signed by the manufacturer agreeing to repair, restore or replace any defective equipment specified in this section during the specified warranty period

1. Warranty Period: 1 year from date of substantial completion.

B. Battery: The battery manufacturer’s warranty shall be passed through to the final customer and shall have a minimum period of one year.

310.040 FACTORY ACCEPTANCE TEST

A. Factory testing units of at least one UPS system of each rating to be supplied shall be witnessed by the Engineer. Selection of UPS system for witness test shall be randomly carried out by the Engineer. Witness test shall include complete routine and function testing on all units to be witnessed. Test procedure and program shall be submitted for approval prior to test conduction. Factory witness test shall include for business class air tickets, five stars Hotel full accommodation, transportation and all test expenses for two persons from the Engineer’s/ Employer’s side.

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310.050 SPARE PARTS AND EXTRA MATERIAL

A. Spare Parts: Provide and deliver to client stores manufacturer's recommended spare parts for one year operation of UPS system. Spare parts shall include as a minimum complete set of fuses for all types and ratings along with cooling fans.

B. Provide list of manufacturer's spare parts for five years operation together with current prices.

C. Tools and Instruments: Provide tools and instruments required for normal routine inspection, testing, operation and general maintenance, as recommended by the manufacturer.

320.000 SUBMITTALS

A. Equipment Data: Submit full technical data of equipment for approval including, but not limited to, the following:

1. Manufacturers' catalogues, detailed description, compliance with the Standards, dimensions and weights, system operation, operating characteristics, methods of operation, protective and control provisions, heat losses, ambient conditions and limitations on electronic components, inverter cut-off voltage, battery calculation to IEEE 485, etc. beyond which such components may suffer partial or permanent damage.

B. Shop and Construction Drawings: Submit drawings for approval including, but not limited to, the following:

1. Plans and front and side elevations, with indication of built-on control and indicating devices and instruments, exact dimensions and weights, cabling etc.
2. One-line diagram with ratings of each piece of equipment, cabling, grounding etc.
3. Control and elementary diagrams, wiring diagrams and the like.
4. Installation and mounting details.
5. Batteries arrangement and mounting details.

C. Point-wise compliance statement to the specifications, duly signed by the manufacturer / manufacturer's authorized representative and the contractor.

D. Manufacturer Certificates: Signed by manufacturers certifying that they comply with requirements.

E. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

F. Test Certificates: Submit type test and routine test certificates. System shall undergo a functional and load test program approved by the Engineer, and shall undergo a minimum 8 hours 'burn-in' test, under site simulated conditions, prior to shipment.

G. Field Test Reports: Indicate test results compared with specified performance requirements, and provide justification and resolution of differences if values do not agree.

H. Maintenance Data: For UPS units to include in maintenance manuals specified in Division 01. Include the following and to the satisfaction of Employer's requirements:

1. Lists of spare parts and replacement components recommended being stored at Project site for ready access.
2. Detailed operating instructions covering operation under both normal and abnormal conditions.

330.000 EXECUTION

330.010 INSTALLATION

A. Equipment Bases: Ensure that concrete bases and foundations provided for installation of equipment are constructed in accordance with approved shop and construction drawings and equipment manufacturers' drawings and that holes for fixing bolts and provisions for passage of cables etc. are provided as required.

B. Built-In Items: Ensure that equipment supports, fixings and the like, and sleeves for passage of feeders and cables which shall be built into concrete foundations, bases or building structure are provided as and when required and that they are properly installed.

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C. Tools: Use only tools recommended by equipment manufacturers for installations, particularly in making connections and adjustments.

D. Supervision: Carry out equipment installation under the direct supervision of a qualified technician, licensed by and trained at the factory. Final adjustments and putting into satisfactory operation shall be made by a specialist delegated by the factory.

330.020 IDENTIFICATION

A. Identify components and wiring according to Division V Section "Basic Electrical Materials and Methods."

330.030 BATTERY EQUALIZATION

A. Equalize charging of battery cells according to manufacturer's written instructions. Record individual-cell voltages.

330.040 FIELD QUALITY CONTROL

A. Electrical Tests and Inspections: Perform tests and inspections according to manufacturer's written instructions and as listed below to demonstrate condition and performance of each component of the UPS:

1. Inspect interiors of enclosures, including the following:

a) Integrity of mechanical and electrical connections.
b) Component type and labeling verification.
c) Ratings of installed components.

2. Test manual and automatic operational features and system protective and alarm functions.

a) Test communication of status and alarms to remote monitoring equipment.

B. Power Supply Output Disturbance: Provide microprocessor based instrument, and monitor and record power supply output disturbance of voltage and frequency. Instrument details shall be submitted for approval.

C. Test Periods shall be prolonged (over 24 hours) and as requested by Engineer, to verify and obtain realistic voltage and frequency profile under any loading and switching conditions within the criteria specified.

D. Data logging shall include high and low average voltage, sags and surges, spikes and spike bursts, drop-outs, high and low frequencies etc. with print-out and storage on cassette tape for subsequent re-entry into instrument's memory for display or print-out.

E. Tests shall include loads at various power factors from low-load to overload condition, and measurements of temperature, heat losses, output voltage, wave shape, and harmonic content and frequency stability.

F. Retest: Correct deficiencies and retest until specified requirements are met.

G. Record of Tests and Inspections: Maintain and submit documentation of tests and inspections, including references to manufacturers' written instructions and other test and inspection criteria. Include results of tests, inspections, and retests.

330.050 GROUNDING

A. Provide direct interference free grounding circuit in accordance with Division Y Section "Earthing and Bonding" of the Specification.

330.060 DEMONSTRATION AND TRAINING

A. Train Employer's maintenance personnel to adjust, operate, and maintain the system installation.

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V33 - DC CENTRAL BATTERY SYSTEM FOR EMERGENCY LIGHTING

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. This Section includes central battery system for emergency lighting that monitors individual luminaires, automatically sense loss of normal AC supply and transfer loads from normal AC to battery DC supply on supply power failure, and that automatically retransfer to normal supply when normal power is restored along with central monitoring and automatic testing for all system components.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Standards: the emergency lighting system shall comply with the following standards:

1. DIN/VDE 0108-100 “Sicherheitsbeleuchtungsanlagen”.
2. EN 50171 “Central Power Supply Systems”.
3. EN 50172 “Emergency Escape Lighting Systems”.
4. EN 50272-2 “Safety Requirements for Secondary Batteries and Battery Installations – Part 2: Stationary Batteries”.
5. IEC 62034 “Automatic Test Systems for Battery Powered Emergency Escape Lighting”.
6. IEC 60896 “Stationary Lead Acid Batteries”.
7. IEEE 485 “IEEE Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications”.
8. IEC 61347-1 “Lamp Controlgear - Part 1: General and Safety Requirements”.
9. IEC 61347-2-11 “Lamp Controlgear - Part 2-11: Particular Requirements For Miscellaneous Electronic Circuits Used with Luminaires”.
10. IEC 61000-6-2 “Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity for industrial environments”.
11. IEC 61000-6-3 “Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments”.
12. BS EN 1838 “Lighting Applications – Emergency Lighting”
13. BS 5266-1 “Emergency Lighting – Part 1: Code of Practice For the Emergency Escape Lighting of Premises”.

110.020 DEFINITIONS AND ABBREVIATIONS

A. BMS: Building management system.

B. CBS: Central battery system.

C. LED: Light-emitting diode.

D. VRLA: Valve-regulated lead acid.

120.000 SYSTEM DESCRIPTION

120.010 GENERAL REUIREMENTS

A. Emergency lighting system shall provide an average of 1 lux illumination level with a maximum to minimum illumination uniformity of 40:1, throughout the facility unless otherwise required by the local codes, whichever is more stringent.

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B. Emergency lighting system shall operate for 1 hour(s) duration while achieving the illuminance level stated in paragraph 120.010A above at the end of the battery discharge period.

C. Emergency lighting system shall be able to control each individual fixture's switching mode as maintained, non-maintained or switched maintained modes connected to the same circuit without additional dataline.

D. The battery and system design shall be capable of meeting the declared performance initially, during and at the end of the stated life.

E. In general, emergency lighting shall be provided by using lamps from the luminaires used for the main normal illumination, unless otherwise shown on drawings.

F. BMS Interface: CBS shall interface to the Management Level Network through a BACnet/IP to third party gateway. The gateway shall be provided by the CBS supplier and shall be connected into the Management Level Network by the BMS contractor. The BMS contractor shall obtain a list of the BACnet object IDs/names from the CBS supplier.

120.020 SYSTEM OPERATION

A. Under normal conditions the load shall be fed from the normal AC power supply through the change-over switch and the battery is re-charged up to full charge state via the battery charger. The battery is maintained in an idle condition ready to feed the load, with continuous monitoring of its output for healthy conditions with an alarm to be initiated in case of malfunction.

B. Upon loss of normal power supply, the load shall be automatically transferred to DC battery supply through the change-over switch and power shall be supplied from the batteries until the normal supply returns, upon normal power supply restoration then the load is retransferred to the normal supply.

C. If the normal power supply failure period exceeds the rated duration of the battery, the load shall be automatically shut down to protect the battery from deep discharge. The system shall automatically reset itself upon normal power supply return.

120.030 MECHANICAL CONSTRUCTION

A. The battery housing shall be sheet steel, powder coated housing IP 21 with removable screwed front, rear and top doors to provide complete access to the batteries. The electronics section shall have IP 21 sheet steel enclosure with transparent polycarbonate window for all central systems and IP 21 sheet steel enclosure with full metal door for all substations. Doors and removable panels shall be so fastened that access to dangerous live parts is not possible without the use of a tool or key. Wireways shall be smooth and free from sharp edges, burrs, flashes, etc. which might cause damage to the insulation of the wiring parts. Metal screws shall not protrude into wireways.

B. The enclosures shall be resistant to heat and fire and tested in accordance with EN 50171 requirements.

C. The electronic compartment shall have large cabling compartments with cable entries from top via multiple undrilled removable metal flange plates. All incoming cables and looping circuits shall be connected on protected and fused terminals. All outgoing luminaire circuits shall be connected direct to relevant components via plug-in type terminals not less than 2.5 sq.m.

120.040 ELECTRICAL CONSTRUCTION

A. The system shall be built-up in a modular with all modules being plug-in-type design. The outgoing circuits shall be fed through changeover modules. 1 module shall be used for circuits with maximum load of 6 Amps as per DIN/VDE 0108. Each circuit shall be protected within the system on mains and battery side via screw-in type cartridge fuses on each module. The fuses shall be accessible via front plate of the module. The mains supply and battery mains cable shall be protected by knife edge fuses. The fuse holders shall have handles for simple removal of the fuses, 25 percent spare capacity shall be available in terms of circuits and modules.

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B. The main panel incoming shall be switch disconnector provided with current limiting HRC fuse type, complying with IEC 60269-2, with rated breaking capacity 120kA and manufactured by an approved firm.

C. Each panel shall have a spare fuse carrier with at least 3 fuses for each size used in respective panel.

120.050 CONTROL MODULE

A. The control module shall be composed of a microprocessor control module with plain text 4 line displays with a minimum of 20 characters per line, to provide operative status and luminaire failures.

B. The central battery equipment shall include facilities for monitoring the system function. The following shall be measured:

1. Battery voltage.
2. Battery/charger/discharge current.

C. The following test and monitoring equipment shall be provided:

1. Devices with automatic reset e.g. push button, to simulate a normal supply failure.
2. Isolating devices to isolate the AC supply for checking the duration of the system.
3. Indication of the actual power supply source (normal supply or battery).
4. Indication of the following faults and system condition:

a) Float charge voltage out of the permissible range.
b) Interruption of the battery charging circuit.
c) Failure in charge equipment; no charge current, although normal supply is available.
d) Supply from the battery, although normal supply is available.
e) Warning to be given at least 10 min before deep discharge protection is initiated.
f) Deep discharge protection initiated.
g) Failure of a powered ventilation system for battery cabinet or battery option.

D. LEDs shall indicate as a minimum:

1. Mains operation.
2. Battery operation.
3. Fault.
4. Deep discharge.

E. Potential free indicator contacts shall be provided for:

1. Operation.
2. Battery operation.
3. Summary fault.

F. Centronic interface for the connection of standard printers shall be provided on the front of the control module. An electronically controlled 24 V output for the voltage monitoring of lighting sub distribution panels shall be provided.

G. Electronically isolated mains monitoring shall be provided for maintained and non maintained light circuits, with forced changeover in case of mains failure from mains to emergency light operation. As a standard following programming modes shall be available.

1. Manual reset.
2. Time delay of mains return.
3. Stair well light timer adjustable from 1 to 15 minutes, where shown on Drawings.
4. Acoustic alarm in case of mains failure, manual reset or summation.

H. Individual changeover shall be provided per emergency circuit with free programming for maintained, non-maintained or switched maintained light and 2 pole fusing conforming to VDE.

I. Failure recognition for each individual safety/exit luminaire in conjunction with proprietary electronic ballasts including 2 wire monitoring module without additional data line.

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120.060 CHANGEOVER MODULE

A. Each changeover module shall be freely programmable to suit type of luminaires connected on outgoing circuits and switching mode of each individual luminaire i.e. maintained, non-maintained or switch maintained. The individual luminaires monitoring circuits shall be included in the changeover module. Each circuit in the changeover module shall have LED indications for circuit on and lamp failure and shall be fit to monitor 20 luminaires as a minimum. All outgoing circuit terminals shall be provided to monitor the sub distribution boards. As an alternative, modules constructed using printed circuit may be provided.

120.070 MONITORING / ADDRESS MODULE

A. Monitoring module shall be provided for luminaire with standard electronic ballast and connected to the central battery system. Monitoring module shall be compatible with electronic ballasts from any manufacturer with the following features: it must be able to operate with both AC and DC voltage, it must shut itself off in an event of a lamp failure, input current in shut off mode must be less than 10mA and must have constant power output high frequency electronic control gear / transformer. The electronic ballast shall be "CE" marked and shall comply with IEC 60929.

B. Monitoring / address modules shall comply with IEC 61347-1 and IEC 61347-2-11.

C. Monitoring modules shall be able to accept 230 V AC at 50 Hz and 220 V +25/-20 % DC. Monitoring / address modules shall be protected against reverse polarity. Monitoring / address module shall have IP 20 degree of protection to IEC 60529 and a flame retardant housing.

D. Monitoring / address modules shall have selector switches for 20 addresses as a minimum and shall have a 230 V AC control input connected to the branch circuit from a node after the switch in case of switched maintained fixtures. Fixtures fed from two sources where shown on drawings such as a dimmed general lighting or switched maintained circuits shall be provided with monitoring module with an integrated changeover or a separate switch controller such that in case of battery operation either in mains failure or testing the fixture is fed from the battery source. Emergency fixtures controlled through DALI protocol shall be provided with monitoring module with DALI control input.

120.080 ELECTRONIC ADDRESSABLE BALLASTS AND LED CONTROL GEARS FOR EXIT SIGNS

A. Safety and exit luminaires shall be provided with high frequency electronic addressable ballast without monitoring module or LED electronic gear in case of LED luminaires, with 20 addresses as a minimum for function monitoring in DC-operation without additional data line and free programmable switching mode as maintained, non-maintained or switched maintained luminaires in one circuit without additional data line. Ballasts shall able to operate with both AC and DC voltage and shall have automatic lamp detection including automatic switch-off in the event of a lamp defect and automatic restart after lamp replacement.

B. Electronic addressable ballast shall comply with IEC 60929, IEC 61347-2-3 and IEC 61347-2-4. Electronic LED control gear shall comply with IEC 61347-2-13 and IEC 62384

C. Electronic addressable ballast and LED control gear shall meet the limits of main harmonic content as defined in IEC 61000-3-2 and comply with radio interference suppression limits defined in BS EN 55015 and immunity requirements of IEC 61547. Ballasts shall have Efficiency Index EEI=A2, power factor corrected to above 0.9. The electronic ballast shall be "CE" marked and shall comply with IEC 60929. All electronic addressable ballasts and LED control gear for the exit luminaires shall be manufactured by the emergency central battery system manufacturer.

D. LED electronic control gear shall be high efficiency, high power factor, suitable for operation at the ambient conditions specified for the project. Control gear shall have constant output current or constant output voltage over the whole wattage range independent of mains supply fluctuations as shown on drawings and sufficient for operating the number and wattage of LEDs connected.

E. Control gear shall have electrical insulation between primary and secondary sides. Maximum length between control gear and LED module shall be as per manufacturer's recommendations.

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F. Electronic addressable ballasts and LED control gear shall be able to accept 230 V AC at 50 Hz and 220 V +25/-20 % DC. Ballasts shall be protected against reverse polarity. Ballasts shall have IP 20 degree of protection to IEC 60529 and a flame retardant housing.

G. Whenever the main lighting fixtures are used as emergency lighting or exit signs are obtained from manufacturer different than that of the CBS, the Contractor shall ensure coordination between both manufacturers. Central battery supplier shall provide necessary addressable modules for each fixture.

120.090 LOCAL CONTROLLER / BRANCH CIRCUITS MONITORING MODULE

A. Final branch lighting circuits feeding non maintained or switched maintained emergency fixtures shall be monitored for operation through single or 3 phase voltage monitor, as the case may be, installed in the lighting sub-distribution boards or a single phase control relay shall be installed in final circuit when required. The non-maintained and switched maintained luminaires shall be lit during a local supply failure. However the emergency supply panel shall not switch to battery use as long as its own mains supply is available. The Local Controllers should comply with IEC 61347-1 and IEC 61347-2-11.

120.100 CHARGER

A. Charger module shall be micro processor controlled module with temperature controlled voltage charging to IU characteristics. Automatic boost charging facility shall be built in to the system depending on the required total battery capacity. It shall have charging and supervising method for failure indication of battery circuits as well as battery charger. Battery chargers shall be capable of automatically charging their batteries that have been discharged so that they can perform at least 80 % of their specified duration within 12 h of commencement of charge in accordance with EN 50171. The charger shall have built in deep discharge protection and shall be provided with LED indications for:

1. Operation.
2. Charger on.
3. Booster on.
4. Mains operation.
5. Battery capacity >10 percent, >50 percent, 100 percent.
6. Charging failure.
7. Insulation fault.

B. Charger shall have potential free indicator contacts for:

1. Charging failure.
2. Fast charge.
3. Insulation fault.

C. The battery charger shall be so designed that a short circuit on its output will not cause damage.

D. Charger shall have a push button to simulate earth leakage failures. Charger shall include plug-in-type terminals as well as the protection fuses for mains and battery accessible via the front plate of the charger.

120.110 BATTERIES

A. Batteries shall be maintenance free, VRLA sealed leak proof 220 V and in compliance with IEC 60896. Batteries shall have extremely low gas generation, low self discharge and have permanently sealed pressure release vents.

B. Battery ampere-hour rating shall be sufficient for emergency period specified with all luminaires operating at full luminous output, to a discharge limit of not less than 1.75 V per cell. Cells shall be normally maintained at 2.25 V per cell. Guaranteed life shall not be less than 10 years, with a capacity drop down to not less than 80% under normal expected service. At the end of the specified duration for the system, the output voltage shall be not less than 90% of the nominal voltage at the

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nominal load. Battery strings shall consist of 18 blocks of 12 V batteries. Batteries shall consist of one string for ratings up to 10 kVA and of two strings for rating above 10 kVA.

C. Batteries shall be installed and provision for maintenance made in accordance with EN 50272-2 and manufacturer's recommendations.

D. Date of manufacture shall be stamped on each battery and shall be less than 3 months from the date of delivery to the site.

E. Battery calculations according to IEEE 485 shall be carried out by the CBS supplier and submitted for approval, based on the following:

1. Nominal active power factor of not less than 0.9 Lag
2. Temperature factor for operation at 25 Deg C.
3. Aging factor of 1.25.
4. Design margin factor of 1.15.
5. Recharge time not exceeding 12 hours so that the battery can perform at least 80 % of their specified duration.

120.120 CENTRAL MONITORING DEVICE

A. The central monitoring shall be via central group monitoring hardware and software, monitoring and programming unit. The unit shall operate with latest visualization software to give detailed text, address and information of all luminaires connected to system. It shall have programming/automatic testing facility for time duration test, function test, location of luminaire, manual rest and acoustic alarm. It shall have facility for software interface to the BMS to provide transmission of all data records as desired.

120.130 AUTOMATIC AND CYCLIC FUNCTION MONITORING AND LOGGING FACILITY

A. Automatic test system shall comply with IEC 62034.

B. An automatic test unit with a recording facility shall be installed with the following features as a minimum:

1. Constant monitoring of the charge, the intervals shall be less than 5 minutes where monitoring is periodic.
2. Cyclical monitoring of switching and functional capacity of the connected load for the emergency power supply. Test shall be carried at least once every week with a test duration between 10 seconds and 5 minutes provided that the total is less than 10 minutes per week.
3. Recording of any faults in the central power supply system and any fault in the test equipment or central monitoring.
4. Fault notification where there is a fault in the transmission route to the central monitoring point.
5. A facility for manual initiation of the test on the central power supply or on the central monitoring unit.

C. If a mains supply failure occurs up to four hours before a programmed functional test, the test shall be postponed and rescheduled for between 4 h and 24 h after restoration of the mains supply. In the event that a functional test is postponed, indication of the pending test shall be given on the remote panel. If a mains supply failure occurs up to 24 h before a programmed rated duration test, the start of the test shall be postponed and rescheduled within seven days after restoration of the mains supply.

D. The limited duration test shall be performed for two thirds of the rated duration. The central emergency power supply system shall be automatically checked to ensure that the battery has not discharged to a lower voltage than is required for a discharge of two thirds of the rated duration.

120.140 WIRING

A. Internal wiring used to carry AC supply and safety equipment circuits shall be separated from each other by running through separate compartments or by double insulation.

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B. All wiring shall comply with the requirements of Division Y Section “Low Voltage Electrical Power Conductors and Cables”.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and Division A Specification Sections, apply to this Section.

210.000 RELATED SECTIONS

A. Related Sections include the following:

1. Division V Section "Basic Electrical Materials and Methods".
2. Division V Section “Interior Lighting”.
3. Division V Section “Fuses”.
4. Division Y Section “Panelboards”.

PART 3 PRODUCTS AND WORKMANSHIP

300.000 MATERIALS

300.010 MANUFACTURERS

A. Approved Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

1. Cooper Ceag
2. Teknoware
3. Inotec

300.020 PRODUCTS

A. Products: Subject to compliance with requirements, provide one of the products indicated for each designation AS shown on plans.

310.000 QUALITY MANAGEMENT

310.010 QUALITY ASSURANCE

A. Manufacture’s Certification: The manufacturer shall be specialized in manufacturing of central battery system as specified in this document. The manufacturer shall be ISO 9001 certified and shall design to internationally accepted standard.

B. Factory Testing: Prior to shipment the manufacturer shall complete a documented test procedure to test all functions of the central battery system and batteries (via a discharge test), when supplied by the CBS manufacturer and guarantee compliance with the specification. The manufacturer shall submit a copy of the test report. Tests shall comply with EN 50171 for the central battery system and with IEC 62034 for the automatic test system.

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C. Materials and Assemblies: All materials and parts comprising the CBS shall be new, of current manufacture, and have not been in prior service, except as required during factory testing. All active electronic devices shall be solid state and not exceed the manufacturer's recommended specified tolerances for temperature or current to ensure maximum reliability. All semiconductor devices shall be sealed. The manufacturer shall conduct inspection on incoming parts, modular assemblies, and final products. Materials and components shall be manufacturer's latest design, and Standards used shall be approved prior to manufacture.

D. Installer Qualifications: Experienced installer who is an authorized representative of CBS manufacturer for both installation and maintenance of system required for this Project.

E. Local Representative: Provide evidence that proposed equipment manufacturer has a locally established and authorized organization which can be called upon for professional advice and maintenance as may be required, and which can immediately supply spare parts to support day to day and emergency maintenance requirements. Failure to satisfy Engineer may disqualify a manufacturer.

310.020 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle equipment as per Manufacturer's instructions.

B. Equipment containing batteries shall not be stored for a period exceeding 3 months without powering up the equipment for a period of 8 hours to recharge the batteries. Relevant Certificate for the batteries production date shall be submitted to the Engineer.

310.030 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace central battery system and replace batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period: One year warranty from the date of substantial completion for central battery system and batteries.

310.040 SPARE PARTS AND EXTRA MATERIAL

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to client stores.

1. Fuses: 25 percent of each type and rating, but no fewer than 3 of each type.
2. Cabinet Ventilation Filters where applicable: One complete set.
3. Change Over Modules: 10% percent, minimum one unit of each type.
4. Circuit Board: One spare circuit board for each critical circuit.

320.000 SUBMITTALS

A. Product Data: for each type and rating of central battery equipment unit include dimensions and data on features and components for each product specified. Include data on electrical ratings, operating characteristics, operating weights, furnished options, specialties and accessories. Include a detailed description of operating modes and any load limitations that may apply.

B. Shop and Construction Drawings: For each type and rating of central battery equipment unit include plans, elevations, sections, and mounting details. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, ventilation requirements, method of field assembly, components, and location and size of each field connection. Include block diagram for BMS interface points. Include system one-line diagram, internal and interconnecting wiring; and diagrams for power, signal, and control wiring. Include elevation, details, and legends of control and indication displays. Include circuit current (withstand) rating of unit.

C. Point-wise compliance statement to the specifications, duly signed by the manufacturer / manufacturer's authorized representative and the contractor.

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D. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around central battery equipment. Show central battery equipment layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

E. Qualification Data: For firms and persons specified in "Quality Assurance" Article..

F. Product Certificates: For each type of central battery equipment.

G. Sample Warranty: For special warranty.

H. Guarantee certification for 10 years battery operation as a minimum.

I. Operation and Maintenance Data: For central battery equipment to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Division 01:

a) Manufacturer's written instructions for testing, adjusting, and reprogramming control modules.
b) Manufacturer's written instructions for selecting and setting field-adjustable controls and status and alarm points.

J. Source quality-control reports.

K. Field quality control report.

L. Records and Reporting: on completion of the work, drawings of the emergency escape lighting installation shall be provided and retained on the premises. The drawings shall be made in accordance with EN 50171 requirements. In particular, they shall identify all luminaires and the main components, and shall be regularly updated with any subsequent changes to the system. These drawings shall be signed by a competent person to verify that the design meets the requirements of this standard.

M. Log Book: a log book shall be provided for the recording of routine examinations, tests, defects and alteration. These shall be available as a hard copy automatically printed from an automatic testing device.

330.000 EXECUTION

330.010 EXAMINATION

A. Receive, inspect, handle, and store central battery equipment according to manufacturer’s recommendations.

B. Examine areas, surfaces, and substrates to receive central battery equipment, with Installer present, for compliance with requirements for installation tolerances, structural support, ventilation, temperature, humidity and other conditions affecting performance of the Work.

1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment will be installed, before installation begins.

C. Examine equipment before installation. Reject equipment that is wet, moisture damaged, or mold damaged.

D. Examine routing layout for electrical connections to verify actual locations of connections before installation.

E. Proceed with installation only after unsatisfactory conditions have been corrected.

330.020 INSTALLATION

A. Clearance: According to manufacturer's written instructions, but not less than 900 mm in front of unit.

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B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

C. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

330.030 IDENTIFICATION

A. Identify equipment and components according to Division V Section "Basic Electrical Materials and Methods" and shall comply with EN 50171.

330.040 FIELD QUALITY CONTROL

A. Tests: Perform tests listed below according to manufacturer's written instructions. Test unit functions, operations, and protective features. Adjust to ensure operation complies with Specifications. Perform tests on completion of unit installation and after building circuits have been energized. Provide instruments to permit accurate observation of tests. Include the following tests:

1. Simulate Malfunctions: Verify protective device operation.
2. Demonstrate low-battery-voltage shutdowns, and transfers due to normal source failure and restoration.
3. Verify emergency-supply duration.
4. Test for Successful Supply: Operate each type of load served by the unit for this Project without symptoms of abnormal supply such as noise, vibration, or pulsation of the load or its output.

B. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

330.050 CLEANING

A. On completion of installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and abrasions in finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer.

330.060 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until controllers are ready to be energized and placed into service.

B. Replace central battery equipment whose interiors have been exposed to water or other liquids prior to Substantial Completion.

330.070 COMMISSIONING

A. Battery Equalization: Manually equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

330.080 DEMONSTRATION

A. Train Employer's maintenance personnel to adjust, operate, and maintain the system installation. Refer to Division A Section "Demonstration and Training and Closeout Procedures."

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V41A - EXTERIOR LIGHTING

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. This Section includes exterior lighting units with luminaires, lamps, ballasts, poles/support structures, and accessories and related power distribution and control, protective earthing and related builder's work including column foundations, cable pits, cable trenches and ductwork.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Standards: Luminaires generally are to comply with IEC 60598 and the applicable CISPR recommendations. Manufacturer is to verify compliance with these standards and the applicable local regulations and design standards.

B. Standards: Comply with the following Standards:

1. LED Fixtures:

a) IEC 60598 “Luminaires”.
b) IES LM-79-08 “Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products”.
c) IES LM-80-08 “Approved Method: Measuring Lumen Maintenance of LED Light Sources”.
d) IES TM-21-11 “Projecting Long Term Maintenance of LED Light Sources”.
e) EN 55015 “Limits and Methods of Measurement of Radio Disturbance Characteristics of Electrical Lighting and Similar Equipment”.
f) IEC 62471 “Photobiological Safety of Lamps and Lamp Systems”.

2. LED Drivers:

a) IEC 61347-1 “Lamp Controlgear - Part 1: General and Safety Requirements”.
b) IEC 61347-2-13 “Lamp Controlgear - Part 2-13: Particular Requirements for D.C. or A.C. Supplied Electronic Controlgear for LED Modules”.
c) IEC 62384 “DC or AC Supplied Electronic Control Gear for LED Modules - Performance Requirements”.
d) IEC 61000-3-2 “Electromagnetic Compatibility (EMC) - Part 3-2: Limits - Limits for Harmonic Current Emissions (Equipment Input Current ≤ 16 A per Phase)”.
e) EN 55015 “Limits and Methods of Measurement of Radio Disturbance Characteristics of Electrical Lighting and Similar Equipment”.
f) IEC 61547 “Equipment for General Lighting Purposes - EMC Immunity Requirements”.
g) IEC 62031 “LED Modules for General Lighting – Safety Specifications”.

110.020 DEFINITIONS AND ABBREVIATIONS

A. Lighting Unit: A luminaire or an assembly of luminaires complete with a common support, including pole, post, or other structure, and mounting and support accessories.

B. Luminaire (Light Fixture): A complete lighting device consisting of lamp(s) and ballast(s), when applicable, together with parts designed to distribute light, to position and protect lamps, and to connect lamps to power supply.

120.000 SYSTEM DESCRIPTION

120.010 LIGHTING COLUMNS

A. Lighting columns shall comply with BS EN 40 and MINEA General Technical Specifications.

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B. Construction: Columns are to be circular section, tapered, formed sheet steel, electrically welded, and of height specified. Columns up to 12-m height are to be one piece section. Columns above 12 m and up to 20-m height may be supplied in two piece sections, of the slip joint type with sufficient overlap to ensure correct vertical alignment of column after assembly. Columns wall thickness shall comply with MINEA General Technical Specifications or of 3 mm at base whichever is more stringent. Sheet steel is to have minimum rupturing resistance of 37 kg/mm2 and minimum yield strength of 24 kg/mm2.

C. Top of column is to be designed to receive single or double arm brackets or other arrangement required, supporting number of luminaires shown on the Drawings. Bracket arrangement is to be designed to ensure that failure, due to wind induced oscillations, does not occur and that rotation from desired alignment is not possible.

D. Column Design: Column cross-section, thickness of steel, joints, welds, bolts etc. are to be designed to withstand gust wind velocity of 160 km/hr blowing in the most unfavorable direction at a height 10 m above ground level, with column fully equipped. Fatigue of steel is in no case to exceed half elasticity limit, taking into account dynamic stresses due to vibrations. Steel flange plate, of adequate thickness, is to be solidly welded onto lower edge of column as shown on the Drawings, and is to have specified number of holes for holding down bolts together with central cable access hole not less than 150 mm diameter.

E. Access door of weatherproof construction is to be positioned at column base and is to be suitably sized to insert and service the supply cable terminations and protective device. Door is to be flush fitting with retaining mechanism and positive locking arrangement with removable hexagonal key. Column is to be reinforced at door opening. Opposite each door, a non-hygroscopic baseboard of suitable size to accept appropriate equipment is to be fixed to inside of column by purpose-made brackets. Stainless steel earthing stud with washers and nuts is to be welded inside the column near the access door.

F. Finish: Welds are to be smooth with spatter removed, inside and outside surfaces of column are to be cleaned by pickling or blasting and are to be free of grease. Steel components of columns to be hot-dip galvanized after fabrication. Minimum thickness of zinc coating is to be 500 g/m2 on both inside and outside surfaces of column. Galvanizing is to be to NFA 91 / 121 or BS EN ISO 1461 . Any damage to galvanizing is to be rectified during erection by wire brushing affected area and treating with approved rust converter to the satisfaction of Engineer. Flange plate and inside and outside of column base are to be coated with heavy bitumen paint prior to erection.

G. Protection and Wiring: Columns with one or two luminaires are to be connected over one phase and neutral. Columns with three or more luminaires are to be connected over 3 phases and neutral, unless otherwise shown on the Drawings. Bolted terminals and cable lugs are to be provided with 3 phases and neutral terminals, for incoming and outgoing 3 phase 4-wire cable, and of the sizes shown on Drawings. One circuit breaker, single pole 6 A is to be provided for each phase leading to a luminaire. Circuit breakers are to be compensated and rated for 50 deg. C ambient with interrupting capacity of at least 9 kA, and are to be mounted in weatherproof enclosure at baseboard. Wiring is to be PVC insulated 3 core or 4 core 85-deg. C conductor temperature. Cable is to be at least 4 mm2 copper conductor.

120.020 LIGHT EMITTING DIODE (LED) LIGHTING FIXTURES - GENERAL

A. Light emitting diode shall be a solid state device embodying a p-n junction, emitting optical radiation when excited by an electric current. It shall be part of the LED module which is supplied as a light source. Output color consistency shall be guaranteed and have a Color Rendering Index (CRI) greater than 70 measured in accordance with IES LM-79-08, unless otherwise indicated on drawings.

B. LED luminaires shall comply with IEC 60598 along with MINEA General Technical Specifications.

C. LED luminaires shall be protected against electric shock by means of basic insulation along with either of the following additional safety precautions:

1. Earthing accessible conductive parts such that these parts cannot become live in case of basic insulation failure (Class I to IEC 60598).

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2. Providing double insulation or reinforced insulation with no provisions for protective earthing (Class II to IEC 60598).

D. LED luminaires' efficacy shall be as shown on Drawings or 75 lumen per watt whichever is more stringent.

E. Guaranteed rated life (L80B50) shall not be less than 50,000 hours at 40 deg. C, as per IES LM-80-08, Approved Method: Measuring Lumen Maintenance of LED Light Sources and IES TM-21-11, Projecting Long Term Maintenance of LED Light Sources.

F. Luminaires guaranteed lifetime shall cover all fixtures components including lamp, fixture and drivers.

G. LED luminaires shall be suitable for 24/7 continuous operation at 50 deg. C with no negative effect on the specified luminaire life time at 50 deg. C and / or performance in terms of color temperature shifting and lumen output.

H. LEDs shall comply with Photo-biological Safety of lamps and lamp systems in accordance with the requirements of IEC 62471. Provide a test report to prove the fixture is classed as "Exempt" or "Risk Group 1".

I. Each luminaire type shall be binned within a five-step MacAdam Ellipse to ensure color consistency among luminaires, unless more stringent requirements are indicated on Drawings.

J. EMI/RFI shall meet EN 55015 requirements.

K. The maximum percentage of direct up-light from the outdoor luminaires shall be as CIE 126-1997.

L. Housing, for non-linear luminaires, shall incorporate an adequate heat sink, the design of the heat sinks shall be such that there is a direct thermal path from the LED junctions to the atmosphere thus providing a thermal transfer effect throughout the life of the luminaire which ensures the overall fittings and the LEDs are kept relatively cool and any heat generated throughout the life of the fixture at the specified ambient temperature doesn't affect the guaranteed life time and / or luminaire performance.

M. Linear LED lighting strips shall comply with the following in addition to the general requirements listed above:

1. Linear LED strips shall be provided in flexible lengths as required by the installation conditions.
2. Linear LED lighting strips characteristics in terms of IP rating shall suit the area of installation and as shown on Drawings.
3. Linear LED lighting strips characteristics in terms of flexibility shall suit the method of installation (curved or linear) and as shown on Drawings.
4. Linear LED construction shall be properly designed to ensure adequate heat dissipation from the LED junctions to the atmosphere to ensure that the overall strip is kept relatively cool and any heat generated throughout the life of the strip at the specified ambient temperature doesn't affect the guaranteed life time and / or luminaire performance.
5. Linear LED strip channels/profiles degree of protection shall match the specified IP rating and shall ensure proper heat dissipation throughout the life of the strip such that the guaranteed life time is not affected.
6. Linear LED strip power rating (W/m) shall be within 10% of the specified value.
7. Maximum strip length connected to each LED driver shall be as per manufacturer's recommendation considering the distance from fixture, power and wire cross section.

N. Electronic LED Drivers: high efficiency, high power factor, 230 V, 50 Hz for AC operated fixtures and 12V/24V/48V for DC operated fixtures, suitable for operation at the ambient conditions specified for the project. Driver shall have constant output current or constant output voltage over the whole wattage range independent of mains supply fluctuations as shown on drawings and sufficient for operating the number and wattage of LEDs connected. Guaranteed rated life of the driver shall be 50,000 hours as a minimum.

O. LED drivers shall have electrical insulation between primary and secondary sides. Secondary cables from the driver to LED modules shall be provided by the LED supplier. Maximum length between driver and LED module shall be as per manufacturer's recommendations.

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P. LED driver shall be protected against electric shock, accidental contact with live parts, short circuit, overload, over temperature where the output current is reduced if the temperature limit is exceeded.

Q. In case LED luminaire internal temperature monitoring is required then the LED driver shall be provided with the possibility to connect a temperature sensor to monitor the LED temperature and protect the LED modules against thermal damage.

R. AC supplied LED drivers shall comply with IEC 61347-1, IEC 61347-2-13 and IEC 62384 and shall meet the limits of main harmonic content as defined in IEC 61000-3-2 and comply with radio interference suppression limits defined in BS EN 55015 and immunity requirements of IEC 61547.

S. DC supplied LED drivers shall comply with IEC 61347-1, IEC 61347-2-13 and IEC 62384 and shall comply with radio interference suppression limits defined in BS EN 55015 and immunity requirements of IEC 61547.

120.030 LED ROAD LIGHTING LUMINAIRES

A. Light source for all road lighting luminaires shall be LED.

B. Construction: Totally enclosed, dust protected and splash proof, conforming to at least IP 65/66 of IEC 60529, shock resistant, U.V. resistant and specially designed to house the LED modules, LED driver and accessories. Body is to be corrosion resistant, extruded, pressure die-cast or fabricated aluminum alloy.

C. Finish: Exposed metal parts of luminaires are to be factory finished, stove enameled, with suitable corrosion resisting paint capable of resisting heat emitted by the light source during continuous operation, and under full sunlight conditions. Color is to be agreed with Engineer.

D. Reflectors shall be polished aluminum, shined and stabilized electrochemically.

E. Luminaire Protectors: Heat and shock resistant glass, mounted into suitable frame assembly fixed to body by captive screws, and secured by extra safety clamps to allow replacement of protector and reflector. Ozone resistant ethylene propylene or approved equivalent rubber is to ensure sealing of the front glass.

F. HRC fuse cartridges, suitably rated and conforming to IEC 60269 or BS 88, are to be provided, complete with base, for protection of the luminaire. Fuse is to be rated to withstand starting current and is to be preferably located in LED driver enclosure.

G. Terminal Blocks: Suitable screw-tunnel type, clearly marked with arrangement to facilitate maintenance, quick replacement and easy disconnection of individual components.

H. All internal wiring shall be with stranded, tinned, annealed, electrolytic copper, high quality heat resistant insulation to 105 deg. Celsius.

120.040 LED FLOODLIGHTS

A. Light source shall be LED.

B. Type: Totally enclosed type, weather, dust and shock resistant, IP 65 to IEC 60529 (unless otherwise shown on drawings), with aiming adjustment facility and “lock-in-place” arrangement.

C. Housing: High pressure die-cast aluminum alloy (color shall be approved by the Engineer) closed on front by hinged framed protector highly resistant to thermal and mechanical shocks, and set in position by at least eight heavy duty stainless steel spring clamps with silicon sealing gasket. Enclosure shall be in accordance with IEC 60598-2-5, and shall be suitable for operation in specified ambient conditions.

D. Reflectors: High purity (over 99% reflectance) anodized aluminum, secured in precision aligned internal tracks to provide beam distribution required.

E. Connection box shall be located at rear of floodlight body with gland connections suitable to accept the supply cables. Light source and control gear/driver to be mounted in two separate and isolated compartments within the luminaire enclosure, unless specifically stated otherwise.

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F. Finish: Exposed metal parts of floodlights are to be painted with U.V. stabilized, corrosion and heat resistant paint (color shall be approved by the Engineer), resisting operating temperatures attained in direct sunlight while lamp is burning.

G. Mounting: Floodlights are to be located as shown on the Drawings and mounted on specially designed brackets to allow swiveling in any desired direction and locking firmly in final position. Protractor scale shall be provided for accurate setting.

H. Earthing Terminals: Bolted earthing terminal shall be provided in each fitting.

I. All fixtures shall be clearly labeled by manufacturer, clearly stating make, model and country of manufacture.

J. Wherever required, antiglare louvers shall be provided to avoid glare to aircrafts.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and Division 1 Specification Sections, apply to this Section.

210.000 RELATED SECTIONS

A. Division V Section "Basic Electrical Materials and Methods".

B. Division V Section "Interior Lighting" for interior fixtures, lamps, ballasts, emergency lighting units, and accessories; and for exterior luminaires normally mounted on buildings.

PART 3 PRODUCTS AND WORKMANSHIP

300.000 MATERIALS

300.010 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, select one of the approved manufacturers.

300.020 PRODUCTS

A. Products: Subject to compliance with requirements, provide one of the products indicated for each designation as shown on plans.

310.000 QUALITY MANAGEMENT

310.010 QUALITY ASSURANCE

A. Technical Requirements: Minor deviations from the Drawings may be considered for improvement in construction details, but no changes are to be made without the written approval of the Engineer.

B. Ambient Conditions: Unless otherwise specified, equipment is to be designed and derated for continuous and trouble-free service at 50 deg. C ambient temperature and 100% relative humidity, with temperature reaching 70 deg. C in direct sunlight and with high content of ultra-violet rays. Equipment is to withstand full load operation whilst exposed to sun.

C. All lighting fixtures shall have test certification from approved, internationally accredited, photometric laboratories.

D. All luminaires shall be sourced either directly from manufacturer or from manufacturer-authorized dealer/agent within Angola, with documentation as necessary.

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E. Obtain specific written confirmation from luminaire, lamp and control gear manufacturers on the inter-compatibility of the equipment/devices to each other and to the specific project conditions.

F. Luminaires and the corresponding accessories shall be compatible with MINEA requirements

310.020 DELIVERY, STORAGE AND HANDLING

A. Store poles on decay-resistant treated skids at least 300 mm above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

B. Retain factory-applied pole wrappings on poles until just before pole installation. Handle poles with web fabric straps.

310.030 SPARE PARTS AND EXTRA MATERIAL

A. Spare Parts: Provide items necessary for maintenance, and up to 5% (or nearest whole unit) of installed quantities of each type of lamp, control gear, fuses, luminaire covers, special bolts or nuts, lamp-holders and the like which are subject to burning, breakage or failure.

B. Furnish extra materials described below that match product installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Fully Equipped LED Lighting Fixtures: 1% of each type and rating installed. Furnish at least one of each type.

320.000 SUBMITTALS

A. Equipment Data: For each type of lighting unit indicated submit complete data for approval including, but not limited to, the following:

1. Detailed literature, in English and Portuguese, for each type of luminaire or fixture, lamp and control gear including manufacturer's name, catalogue number, rating, material specification, overall dimensions, operating characteristics and principles, and any modification to a standard product if applicable
2. Detailed specification and drawings for each column type including shape, base/mounting flanges, bolts, nuts etc, cross-sections, design criteria and calculations, brackets, finishes, provisions for cabling, cut-out or circuit-breaker etc.
3. Photometric data for lighting calculations including polar curves, coefficients of utilization, efficiency and depreciation factors.
4. Materials and dimensions of luminaires and poles.
5. Certified results of independent laboratory tests for fixtures and lamps for electrical ratings and photometric data, including IP rating certification.
6. Life, output (lumens, Color temperature, and CRI) and energy efficiency data for lamps. Lifetime for LED fixtures shall be indicated at an ambient temperature of 25 and 50 deg. C.
7. High-intensity-discharge luminaire ballasts.

B. Shop and Construction Drawings: Submit drawings for approval including, but not limited to, the following:

1. Layout of equipment in exact positions with mounting and construction details, concrete foundation dimensions and reinforcement, routing and sections of duct-banks and trenches, backfill and packing material, earthing rods etc.
2. Cabling and wiring diagrams, single line drawings, loads, phase distribution, protection and control, earthing and the like.
3. Calculations of illumination and glare levels, based on CIE methods.
4. High mast details shall include detailed calculations and supporting data to show that the mast meets the design criteria and shall include the following as a minimum:

a) The deflection at the top of the mast at the designed wind speed.
b) The neutral frequency of the mast.
c) The critical wind speed for resonance.
d) The damping characteristics of the mast.
e) The steel stressed under resonant conditions.
f) The acceleration at the top of the mast under resonant conditions.

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g) Welding procedure.
h) Procedure to ensuring that the flange plate is not laminated.
i) Details of the joints between the mast sections and between the bottom section and the flange.
j) Details of the base compartment with the method of reinforcement at the door area and means adopted for making the door weather and tamperproof.

5. Design calculations indicating the strength of foundations and soil conditions on which they are based.

C. Samples: submit fully equipped sample of luminaire or other materials or components if required by Engineer.

D. Product Certificates: Signed by manufacturers of lighting units certifying that products comply with requirements.

E. Test Certificates: Submit certificates demonstrating LED fixtures compliance with the referenced standards. Include the following as a minimum:

1. Degree of Protection to IEC 60529.
2. Humidity Proof to IEC 60598.
3. Insulation resistance and electric strength to IEC 60598.
4. Color rendering for LED fixtures to IES LM 79-08.
5. LED fixtures lifetime to IES LM-80-08 and IES TM-21-11.
6. Efficacy to IES LM-79-08.

F. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

G. Maintenance Data: For lighting units to include in maintenance manuals specified in Division 1.

H. As-Built (Record) Drawings: At Project close-out, submit Record Drawings of installed lighting, in accordance with requirements of the Specification, Division 1.

330.000 EXECUTION

330.010 INSTALLATION

A. Equipment: Install equipment to be readily accessible for operation, maintenance and repair. Minor deviations from the Drawings may be made to accomplish this but no changes are to be made without the approval of Engineer.

B. Column Bases: Install columns on concrete bases as detailed on the Drawings. Before commencement of construction, ensure that bases are suitable for column installation.

C. Holding Down and Plumb Adjusting Nuts, Washers, Locknuts or Nyloc Nuts: Stainless steel or cadmium plated.

D. Columns: Erect columns so that luminaires are located on a line parallel to theoretical profile of road. Alignment of columns, both horizontally and vertically, is to be secured to the satisfaction of Engineer. Brackets are to be set at 90 degrees to longitudinal axis of road.

E. Install poles as follows:

1. Use web fabric slings (not chain or cable) to raise and set poles.
2. Mount pole to foundation with leveling nuts, and tighten top nuts to torque level recommended by pole manufacturer.
3. Secure poles level, plumb, and square.
4. Grout void between pole base and foundation. Use non-shrinking or expanding concrete grout firmly packed in entire void space.
5. Use a short piece of 13-mm diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

F. Luminaire Attachment with Adjustable Features or Aiming: Attach luminaires and supports to allow aiming for indicated light distribution.

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G. Mounting Adjustments: After demonstrating to Engineer that specified lighting requirements have been met, carry out final setting and locking in position of the floodlights.

H. Luminaire Attachment: Fasten to indicated structural supports.

I. Lamp luminaires with indicated lamps according to manufacturer's written instructions. Replace malfunctioning lamps.

J. Cabling Conduits and Ductwork: Carry out in accordance with Division Y Section " Low Voltage Electrical Power Conductors And Cables ". Cable ducts are to be directly buried except at crossings with other service work or roads.

330.020 INSPECTION AND TESTS ON SITE

A. Visual inspection is to include inspection of condition of each piece of equipment, quality of workmanship, alignment, perpendicularity, labeling and the like, all in conformance with the Specification.

B. Insulation resistance and continuity tests are to be carried out on each circuit and piece of equipment before energization, with circuit breakers in the open position and lamps not installed.

C. Operational tests are to be carried out on all circuit breakers and control gear, with lamps installed, including recording voltage at terminals of ballasts on final columns of each circuit and at distribution panel or the like.

D. Performance tests are to be carried out after 100 hours normal operation, and are to include measurement of lighting and uniformity levels on required illuminated surfaces.

E. Other tests are to be carried out as required by the Engineer to verify conformity with the Specification.

F. Earthing resistance tests are to include measurement of earth electrode resistance at final points of circuits and continuity of protective conductors.

G. Results of tests are to be recorded on site and signed by witnessing parties.

H. Provide instruments to make and record test results.

I. Tests and Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source, and as follows:

1. Measure light intensities at night if specific illumination performance is indicated. Use calibrated photometers.
2. Check intensity and uniformity of illumination.
3. Check excessively noisy ballasts.

J. Prepare a written report of tests, inspections, observations and verifications indicating and interpreting results.

K. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.

330.030 CONNECTIONS

A. Ground Equipment:

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

B. Ground metal poles/support structures according to Division Y Section " Earthing And Bonding."

1. Nonmetallic Poles: Ground metallic components of lighting units and foundations. Connect luminaires to grounding system with conductor as shown on plans or in accordance with Regulations.

330.040 CLEANING AND ADJUSTING

A. Clean units after installation. Use methods and materials recommended by manufacturer.

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B. Adjust amiable luminaires and luminaires with adjustable lamp position to provide required light distributions and intensities.

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V60 - 400 HERTZ AIRCRAFT GROUND POWER

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. This Section specifies 50 Hz to 400 Hz solid state point of use frequency converters and accessories.

B. Description of Work: Install 50 Hz to 400 Hz frequency converters as indicated on Drawings, in Schedules, and in this Section.

1. The frequency converters shall be mounted under the aircraft end of each loading bridge.
2. Supply aircraft cables with aircraft plugs. Aircraft cable hoist systems at each loading bridge are specified as part of bridge system.
3. Each converter unit shall be equipped with solid-state energy-use metering electronics arranged to accurately measure the KWH power delivered to the system during each aircraft use of the gate. Measured power consumption data will be acquired by the Gate Control Unit (GCU), and will be transmitted for processing of costs.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Institute of Electrical and Electronic Engineers (IEEE):

1. IEEE 519 – Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.

B. American National Standards Institute (ANSI):

1. IEEE C2 National Electrical Safety Code.
2. NEMA ANSI C84.1 - Voltage Ratings for Electrical Power Systems and Equipment

C. National Electrical Manufacturers Association (NEMA):

1. ICS-1 - General Standards for Industrial Control Devices and Systems.
2. ICS-6 - Enclosures for Industrial Control Devices and Systems.
3. ST 20 - Dry Type Transformers for General Applications.

D. Underwriters Laboratory (UL): All components shall be UL listed and labeled except for components, which are not available with a UL listing or label.

E. Air Transport Association of America (ATA): ATA 101 - Ground Equipment Technical Data.

F. DFS4OO (Euro-standard, 400 Hz).

G. International Electrical Commission: IEC 60204-1 - Electrical equipment of Industrial Machines.

H. Compliance with Local Requirements: Comply with applicable local regulations/code requirements of authorities having jurisdiction. This will have precedence over other codes/standards nominated for the project, unless otherwise approved in writing.

120.000 SYSTEM DESCRIPTION

120.010 50 HERTZ TO 400 HERTZ SOLID STATE FREQUENCY CONVERTERS

A. General: Provide 400 Hertz output solid state frequency converters complete with all components, accessories, auxiliary equipment and associated equipment as specified. Provide two (2) different

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sized units, nominal 90 kVA and 120 kVA continuous output as shown and scheduled on the contract drawings. All 120 kVA units shall have dual aircraft cable and plug outputs; 90 kVA units shall have single or dual output cables and plugs as indicated on the drawings or in schedules.

B. Operational Life: The frequency converter shall have a 20 year life when operated within these specifications at any load from no-load to full load.

C. Ambient Conditions: The solid state frequency converters shall operate under any combination of the following ambient conditions without any mechanical or electrical damage, degradation of operating characteristics, or loss of normal life expectancy.

1. Operating Ambient Temperature: 0 degrees C to 50 degrees C.
2. Non-operating Temperature: -40 degrees C to 70 degrees C.
3. Relative Humidity: 10 percent to 95 percent non-condensing for all temperatures within the temperature range.
4. Operating Altitude: Sea level.
5. Non-operating Altitude: 12190 m above sea level.
6. Wind: 137 km/h steady, 200 km/h gusts.

D. Input Power:

1. Voltage: Nominal voltage, 400 volts, 3 phase, 3 wire. Allowable voltage range, 380 volts to 430 volts.
2. Input Power Factor: Unit shall be rated at 0.8 power factor at 400 volts.
3. Frequency: Nominal frequency 50 hertz. Allowable frequency range 49 hertz to 51 hertz.
4. Inrush Current: Shall not exceed 100 percent of rated full load current and shall be equipped with a fully automatic soft start circuit.
5. Protection: The frequency convener shall automatically shut down if any of the following input power conditions exist:

    a) Overcurrent.
    b) Thermal Overload.
    c) Phase Loss.
    d) Phases Out of Sequence.
    e) Over/Under Voltage.

E. Harmonic Distortion: The current harmonic distortion reflected back on the input power line with the frequency converter operating at 50 percent of full load shall not exceed 20 percent maximum and when operating at full load shall not exceed 10 percent maximum. The voltage harmonic distortion shall not exceed 5 percent with the frequency converter operating between 50 percent and full load. The units shall be tested (reference: IEEE 519), in accordance with paragraph titled "Factory Testing" in Pan 3 of this Section.

F. Output Power:

1. Power Rating: Nominal ratings of units are 90 kVA and 120 kVA at 0.8 lagging power factor.
2. Voltage: Nominal voltage 200Y/115 volt, 3 phase, 4 wire, wye connected. Actual delivered single phase voltage 112.0 volts to 118.0 volts, measured at the aircraft plug.
3. Phase Rotation: Shall be ABC left to right, front to back, top to bottom.
4. Frequency: Shall be 400 Hertz ± 0.05 percent at any load.
5. Overload Capacity: After reaching stabilized temperature at full load, the frequency converter shall be capable of carrying the following overloads:

    a) 115 percent for 1 hour, 150 percent for 5 minutes, 200 percent for 10 seconds, 250 percent for 0.5 second.

6. Overload/Short Circuit: The frequency converter shall be isolated (solid state switching or output contactors) from the aircraft load by overload/short circuit protection specifically rated for 400 Hz operation. The converter shall be equipped with an instantaneous electronic overload alarm circuit designed to operate at not less than 250 percent of rated capacity.
7. Over/Under Voltage Protection: An over/under voltage output protection system shall be provided to automatically isolate the converter output power from the aircraft when it is exceeding limits.

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8. Efficiency: The efficiency shall be 95 percent or better at from 51 percent full load to full load, at rated power factor.
9. Voltage Phase Balance: With frequency changer operating at any load within the rated kVA, the maximum difference in all line-to-neutral voltages shall not exceed 2 percent for balanced loads and within 2.5 percent for 25 percent unbalanced loads.
10. Phase Voltage Displacement: Shall be 120 ± 2.0 degrees for balanced loads, 120 ± 2.5 degrees for 33 percent unbalanced loads.
11. Voltage Regulation: Voltage regulation from no-load to rated load and from rated load to no-load shall be not more than 1 percent of rated voltage and shall be maintained with input line voltage variations of + 10, -15 percent.
12. Voltage Modulation: Voltage modulation shall not exceed 1.0 percent at any load from 0 to 100 percent.
13. Voltage Recovery: Transient voltage recovery shall not exceed 200 msec for 100 percent load change.
14. Harmonic Distortion: The maximum total harmonic voltage distortion at any load shall not exceed 3.0 percent when measured line-to-line or line-to-neutral. The maximum single harmonic shall not exceed 1.5 percent of the fundamental voltage at steady state.
15. Frequency Regulation: Shall be 400 Hz ± 0.05 percent and shall not be affected by load.
16. Crest Factor: Shall be 1.414 ± 0.05.
17. Voltage Trim Adjustment: The output voltage trim adjustment shall be ± 15 percent of nominal output span.
18. Line Drop Compensation: Shall be 0 to 5 percent of voltage span and shall be adjustable.

G. Frequency Converter Control: The solid state frequency converter shall have the following control functions and equipment:

1. Momentary start stop push buttons mounted on the converter front panel.

    a) Power On: The remote "power on" pushbutton shall make the 400 Hz power available to the aircraft plug. This power shall be available for only four (4) seconds unless the aircraft plug is connected to the aircraft and the 28 VDC safety circuit is complete.
    b) Power Off: The remote "power off" pushbutton shall turn power off to the aircraft plug. The 400 Hz power shall be turned off instantly if the aircraft plug is removed from the aircraft receptacles by breaking the 28 VDC safety circuit.
    c) Aircraft Interlock Circuit: The "E" and "F" interlock circuit shall instantaneously isolate the converter output in the absence of a 28 VDC signal from the aircraft. The "E" and "F" interlock circuit indicator shall be provided to display the status of "E" and "F" interlock.

2. Isolated, fused 28 volt DC power supply for indication and control devices.
3. Automatic Reset: The reset function shall be accomplished by operation of the "power off" pushbutton.
4. Automatic Restart: The automatic restart function shall restart the unit and bring "Ground Power Available" indication back to the aircraft should the aircraft be configured to overload the unit. Reconfiguring the aircraft to a lower level of power consumption allows continuation of service without manually resetting the unit with controls located on the ramp. The function shall allow three (3) automatic resets. The fourth time shall require the unit to be reset manually.
5. Aircraft Bypass Switch: For testing purposes, an aircraft bypass switch shall be provided inside the converter to allow the unit to deliver the output power without the 28 VDC power from the aircraft. An indicator shall be provided to indicate that the bypass circuit has been selected.
6. Output Voltage Adjust: A voltage adjusting potentiometer located on the back of the primary access panel shall be provided to permit adjustment of the converter output voltage.
7. Bridge Control Interlock: The converter unit and the cable hoist shall be interlocked with the bridge control circuit so that the bridge cannot be moved away from the aircraft while frequency converter is plugged to the aircraft or the load cable is not fully stowed. Provide bypass switch at passenger loading bridge control console, enabling emergency override of interlock feature.
8. Alarm Indicator Reset: A reset pushbutton shall be provided to reset all alarm signals and indications on the inside of the front cover of the converter.

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9. Line Drop Compensation: The voltage regulation means shall include an electronic line drop compensation circuit for maintaining the voltage regulation at a single point distance from the converter and shall be adjustable at full load to at least 5 percent of rated output voltage.
10. Overtemperature Protection: The converter shall automatically shutdown before the inside temperature reaches the maximum temperature rating of any component inside.

H. Meters and Indicators:

1. General: Provide the metering and switching specified by either individual meters and switches or by a combination key pad and LCD/LED readout.
2. Ammeter: The output ammeter shall have a single 0 to 400 A rms scale for 90 kVA units and 0 to 600 A rms scale for 120 kVA units in order to read output phase currents. The ammeter shall be calibrated for 400 Hz and shall have an accuracy of ± 2 percent full scale.
3. Ammeter Selector Switch: A four-position selector switch shall be provided to monitor output phase line-to-neutral currents "A", "B", "C", with "OFF" position.
4. Voltmeter: The output voltmeter shall have a single 0 to 150 VAC scale in order to read line-to-neutral voltages. The voltmeter shall be calibrated for 400 Hz and shall have an accuracy of ± 2 percent full scale.
5. Voltmeter Selector Switch: Four-position selector switch with "OFF" position shall be provided to monitor line-to-neutral voltages.
6. Power Use Metering: Provide analog digital electronic metering module arranged to transmit data to the Gate Control unit (GCU) for kilowatt-hour usage, based on 400 Hz converter input power from 50 Hz system, for each gate use event.
7. Run Time Meter: Non re-settable hour meter with range from 0-99,999 hours.
8. Status Indicators: Provide the following status indicator lights in the colors indicated:

    a) Input Power On - Amber
    b) Converter On - Green
    c) Module Fault - Red
    d) Input Voltage Fault - Red
    e) Output Voltage Fault - Red

9. Lamp Test: The lamp tests pushbutton, when depressed, shall test all door-mounted light indicators and digital display segments.
10. Diagnostic System: The solid state frequency converter shall be equipped with a complete diagnostic system including alarm message system. All of the converter's vital functions shall be continuously monitored by the diagnostic system.
11. System Indicators: The frequency converter shall be equipped with a light emitting diode (LED) status package to provide monitoring of the proper system modules operation.
12. Voltage Adjustment Device: Provide a device, located on the inside of the converter front panel, which can be used to adjust the output voltage while viewing the voltmeter.
13. Status Contacts: Each converter shall be provided with dry contacts to indicate the following (contacts shall be utilized by the Data Acquisition System provided under Pre-conditioned Air system installation):

    a) Run
    b) Stop
    c) Summary Fault

I. Physical Characteristics:

1. The unit shall be so designed and constructed that parts will not work loose in service. It shall be designed to withstand the strains, jars, vibration and other conditions incident to shipping, storage, installation and service.
2. The physical size and weight of the unit shall be suitable to provide integrated loading bridge operation as indicated on the drawings and in specifications.
3. The converter section of the frequency changer shall be modularized solid state components. The standard construction shall have no moving parts and shall require minimum service or maintenance. All cards shall be equipped with vibration resistant latching mechanism.

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4. Components shall be cooled by convection, natural draft cooling, use of heat sinks, or by forced draft cooling provided the overall efficiency of the unit is not reduced by the use of fans. All fans shall be equipped with permanent, washable aluminum mesh air filters.
5. The electronic compartments shall be equipped with environmentally safe vapor type corrosion inhibitors.
6. The frequency converter shall be equipped with approved weathertight fittings for all wiring that passes through the weathertight compartments to preclude the entrance of moisture and dust into electronic compartments.
7. All printed circuit boards shall be conformably coated to protect against the effects of humidity and corrosion. All integrated circuits shall be installed with soldered joints.
8. The frequency converter shall be so constructed that adjustments and repairs can be easily made by maintenance personnel.
9. All major components and sub-assemblies shall be stenciled or labeled with identification number or letter code on or near the device. The code shall be readily visible when servicing the frequency converter.
10. The cabinet enclosure shall be NEMA 3R. The cabinet shall be mounted in such manner that no damage will occur as a result of transportation. The complete frequency changer shall be designed for lifting and transporting by forklift. Means shall be provided for easy access to all components and sub-assemblies.
11. A door interlock switch shall be provided to shut down the unit and suitable warning labels or covers shall be provided where internal voltages decay slowly after shut down. There shall be a means to defeat the door interlock switch for maintenance purposes.
12. The control panel shall be an integral part of the converter cabinet. Provision shall be included for remote controls to operate the frequency converter from remote position. Remote control locations are shown on drawings. Remote control shall perform the same functions as specified on the converter unit integral control panel.
13. The converter and associated parts to meet the harmonic voltage and current criteria specified herein shall be enclosed in a single enclosure. No external parts or equipment will be allowed.
14. Converter unit shall be capable of being locked closed with all units keyed alike.

J. Finishes:

1. Steel surfaces shall be zinc coated (hot galvanized).
2. Aluminum surfaces shall be anodized.
3. All steel parts, except galvanized surfaces not to be painted (not exposed to view), shall be cleaned and a zinc-phosphate pre-treatment applied prior to paint application.
4. Color of exposed surfaces of frequency converters installed on passenger loading bridges shall be as directed by the Engineer.
5. Painting system shall be specially formulated and applied to ensure protection of surfaces from saline dust and high humidity conditions. The average thickness of the paint film shall be 0.05 mm. Paint film shall be uniform in color and free from blisters, sags, flaking and peeling.
6. Adequacy of paint finish to inhibit the buildup of rust on ferrous metal materials shall be tested and evaluated per ANSI C37.20.2. Salt spray withstand tests in accordance with ASTM D1654 and B117 shall be performed on a periodic basis to provide conformance with the corrosion resistance standard of at least 2500 hours minimum.

K. No-Break Power Transfer (NBPT) Capability: The frequency converter shall be capable of withstanding reverse power flow caused by NBPT operations of all known aircraft without damage to any components in the unit or to the aircraft auxiliary power unit (APU).

L. Workmanship: The frequency converter, including all parts and accessories, shall be fabricated and finished in a workmanlike manner. Particular attention shall be given to freedom from defects, burrs, sharp edges, quality of soldering, welding, brazing, painting, wiring, riveting, alignment of parts and tightness of assembly screws, bolts, etc.

120.020 AIRCRAFT LOAD CABLE ASSEMBLIES

A. The aircraft output cable assemblies shall be designed to carry a nominal 115/200 volt, 3 phase, 4 wire, 400 Hz supply from the frequency converter to the aircraft.

B. Each cable assembly shall consist of 1 conductor per A, B, and C phases and 1 neutral conductor.

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1. There shall be one or more 3.5 mm2 (or equivalent) control leads connected to a field-replaceable AN3430 plug with jumper installed between pins E and F.
2. All conductors shall be copper and consist of Class M stranding.
3. The cable shall have a single, heavy duty, neoprene jacket eliminating the need for banding.
4. The cable assembly shall be easily removable for replacement or repair.
5. All cables shall be 20 m in length.

C. Each cable assembly shall be sized to handle the full load current of the indicated frequency converter.

D. The number of cable assemblies per frequency converter shall be as indicated by the number of 400 Hz converter outputs listed on the drawings.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and Division 01 Specification Sections, apply to this Section.

210.000 RELATED SECTIONS

A. Related Sections include the following:

1. Division V Section - "Basic Electrical Materials and Methods".
2. Division Y Section - "Earthing and Bonding".

PART 3 PRODUCTS AND WORKMANSHIP

300.000 MATERIALS

300.010 MANUFACTURERS

A. 400 Hz frequency converters shall be products of a manufacturer regularly engaged in the engineering and fabrication of 400 Hz, solid state, point of use 50 Hz to 400 Hz frequency converters.

B. The manufacturer shall provide evidence of at least 5 years of satisfactory experience in the design and fabrication of point of use solid state frequency converters serving commercial aircraft loads.

C. Approved Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

1. Hochian (UK)

310.000 QUALITY MANAGEMENT

310.010 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer with minimum five years of successful installation experience on projects utilizing 400Hz aircraft ground power similar to those required for this project.

310.020 WARRANTY

A. Manufacturers Warranty: Submit a written warranty signed by the manufacturer agreeing to repair, restore or replace any defective equipment specified in this section during the specified warranty period

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1. Warranty Period: 1 year from date of substantial completion.

320.000 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data, including specifications and installation instructions, for each size and type of solid state frequency converter specified. Include data substantiating that materials comply with requirements.

B. Shop Drawings: For 400Hz aircraft ground power equipment. Include plans, elevations, sections, details, and attachments to other Work.

1. Include dimensioned plan and elevation views of equipment. Show access and workspace requirements.
2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.

C. Coordination Drawings: Plans drawn to scale and coordinating locations of equipment.

D. General: Comply with all requirements of Division 01 Specifications as applicable to quality control and required submittal of inspection records, test reports, and certifications. Submit all factory and field test reports to the Engineer within 14 days of actual test.

E. Harmonic Distortion Test:

1. Submit manufacturer factory harmonic distortion testing procedures and test data with contract bid documents.
2. Submit independent laboratory testing procedures and test data within eight (8) weeks of Notice to Proceed.

F. Certification: Provide certification from each aircraft manufacturer (including Boeing and McDonnell Douglas) that frequency converter is capable of supplying the aircraft load.

G. Solid State Frequency Converter Details (edited to identify exact units to be provided). Submit the following:

1. Drawing of unit to scale with dimensions and weights.
2. Operating details, schematic layout, diagrams, sufficient to completely describe converter.
3. Wiring diagrams with all terminal points and conductors clearly identified.
4. Spare parts list.
5. List of special tools required, if any.

H. Working Procedures: Submit proposed working procedures for the installation/erection of work of this Section to the Engineer for his approval sufficiently in advance of commencing any work affected by the working procedures.

I. Qualification Data: For firms and persons specified in "Quality Assurance" Article. Provide evidence of applicable registration or certification.

J. Tests and Certificates: Submit complete certified manufacturer’s type and routine test records, in accordance with the Standards specified in "Quality assurance" Article.

K. Field Test Reports: Submit written test reports and include the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

L. As-Built Drawings: Submit hard and soft copies with labeling.

M. Maintenance Data: For 400Hz aircraft ground power and components to include in maintenance manuals specified in Division 01. In addition to requirements specified in Division A Section "Contract Closeout", include the following:

1. Detailed operating instructions.

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2. Routine maintenance requirements for system components.
3. Lists of spare parts and replacement components recommended to be stored at the site for ready access.

N. Warranties: Special warranties specified in this Section.

330.000 EXECUTION

330.010 FACTORY ACCEPTANCE TEST

A. Factory acceptance test of equipment under this contract are subject to be witnessed by the Engineer. Witness test shall include complete routine testing. Test procedures and program shall be submitted for approval prior to test conduction. Factory witness test shall include business class air tickets, five stars hotel full accommodation, transportation and all test expenses for two persons from the Engineer's or Employer's side.

330.020 COORDINATION

A. Coordinate layout and installation of 400Hz aircraft ground power and components with other construction and electrical work, including conduit, piping, equipment, adjacent surfaces, raceways, electrical boxes and fittings, and cabling/wiring work. Maintain required workspace clearances.

330.030 START-UP

A. The manufacturer of the units shall furnish a competent factory-based engineer to assist in placing the units in operation and to instruct personnel in their proper use.

330.040 INSTALLATION

A. The units shall be installed on the loading bridge and coordinated with the loading bridge Contractor for loading bridge mounting power connection and 400 Hz cable hoist.

330.050 FACTORY TESTING

A. Harmonic Distortion: Provide independent laboratory test results of input harmonic currents and voltages for both 90 and 120 kVA typical (one unit each) frequency converters. The test shall be completed with a distortion analyzer within 1.5 m of the frequency converter's input terminals with a maximum analyzer lead length of 1 m. The test data shall include total harmonic distortion and amplitudes of individual harmonics in graphic representation for no-load, 25,50, 75, and 100 percent load factors. Submit test procedure and test results from a certified independent laboratory within eight (8) weeks of Notice to Proceed. Provide manufacturer factory testing on one (1) 90 kVA frequency converter in accordance with this section and submit testing procedures and test results with contract bid documents.

B. Provide airfare and lodging (of not less than a 3-star hotel) per diem for three engineers to be assigned by the Engineer for witnessing performance of frequency converter units in tests conducted at the factory. One fully assembled unit of each type and size of unit required for the project shall be tested at design conditions, with output to be recorded and approved by the Engineer before equipment is dispatched from the factory.

C. All frequency converters shall be load bank tested prior to shipping from the factory with test results submitted to the Engineer 20 days prior to shipping to the Work site.

1. Testing: One hour at 50 percent kW capacity and one hour at approximately 100 percent kW capacity.
2. Monitoring: At 15 minute intervals during testing monitor voltage, frequency and amperes.

330.060 FIELD TESTING

A. Prior to acceptance of the installation, seven (7) randomly selected frequency converters shall be tested to show that they are free of defects and will be operated correctly.

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B. The solid state frequency converters shall be subjected to load test through the use of portable load banks supplied for this purpose at the job site by the Contractor.

C. Load bank testing shall be done in the presence of the Engineer or his appointed representative only after all converters are permanently installed in accordance with the plans and specifications.

1. Testing: One hour at 50 percent kW capacity and one hour at approximately 100 percent kW capacity.
2. Monitoring: At 15 minute intervals during testing monitor voltage, frequency and amperes.

D. Supply all material and labor for load bank testing of frequency converters on site.

E. Demonstrate the following six (6) shut down features on all units to Engineer:

1. Removal of the plug connector from aircraft receptacle.
2. Sustained load exceeding 115 percent of rated power.
3. Over or under voltage.
4. Loss of phase or phase rotation reversal.
5. Loss of input power.
6. Loss or interruption of 28 volt DC monitoring voltage.

F. Demonstrate the interlocking operation of the system.

330.070 TRAINING

A. On-site training shall be provided to the Employer's and/or tenant airlines' designated personnel in complete operation and maintenance of the units. The number and duration of training sessions shall be as approved by Engineer.

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V70 - WIRING DEVICES

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. This Section includes wiring devices, lighting switches, socket outlets, cord outlets, automatic and manual lighting control equipment, dimmers, outlet boxes and plates, etc.

B. Components are to be standard manufactured items, uniform and modular, complying with one set of approved Standards.

110.000 SYSTEM DESCRIPTION

110.010 PLATES, GENERALLY

A. Blank Plates: Blank plates are to be installed on outlet boxes, specified under Division 26 Section "Raceways and Boxes for Electrical Systems", on which no apparatus is installed or where apparatus installed does not have suitable cover for box. Blank plates for wall outlets are to be attached by a bridge with slots for horizontal and vertical adjustment.

B. Floor outlets and plates are to be watertight and impact resistant.

110.020 PLATES AND CORD-OUTLETS

A. Design: Square, rectangular or round designed to cover outlet box and to closely fit electrical device, and with polished chromium plated recessed head fixing screws. Combination plates are to be used for grouped outlets and devices.

B. Cord extension plates are to have threaded cord grip bushings of same material and finish as plates.

C. Plastic Plates: Heavy gauge, break resistant, pressure molded plastic, White color, for general use in Back of House (BOH) Areas.

1. Man: Legrand
2. Ref: Arteor series 5752 00, or other equal and approved.

D. Brushed Stainless Steel Plates: Heavy gauge, pressed stainless steel, satin finish, minimum 1 mm thick, for use in Front of House (FOH) Areas.

1. Man: Legrand
2. Ref: Arteor series 5752 06, or other equal and approved.

E. Cable/cord outlet (flex outlet) is to be used for up to 45 A, 250 V rating for connection of power/control cable of fixed appliances, as shown on the drawings. Plate is to have threaded cord grip to anchor cable securely to cover. Box is to include fixed terminal block and cable clamp for termination of cable/cord within.

F. Electrical outlet is to consist of outlet box, coverplate, and necessary accessories ready for connection to cable of fixed appliances.

G. Lighting outlet is to consist of outlet box, coverplate, and necessary accessories ready for connection to lighting fixture.

H. Ceiling rose: similar to lighting outlet equipped with a decorative element affixed to the ceiling from which a chandelier or lighting fitting is suspended. Ceiling rose to comply with BS 67.

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110.030 SWITCHES

A. Generally: Quick-make, quick-break type with silver alloy contacts in arc resisting molded base, with toggle, rocker or push-button as specified, for inductive or resistive loads up to full rated capacity, and arranged for side and/or back connection.

B. Types: Single, two-way or intermediate, single pole or double pole, as shown on the Drawings.

C. General Lighting Switch (S1): 10 A, 250 V a.c., rocker operated, grid-switch with brushed stainless steel and switch module for use in all front of house areas.

D. General Lighting Switch (S3): 10 A, 250 V a.c., rocker operated, grid-switch with Thermosetting plastic with glossy finish white Plate and switch module for use in all back-of-house areas.

E. General Lighting Switch (S4): 10 A, 250 V a.c., rocker operated, grid-switch with metal clad aluminum plate with white switch module for use in technical spaces

F. Remote Lighting Control Panel For Contactor Control: Multiple two way momentary on/off push switch assembly, with an 'on' pilot light for each circuit controlled (remote contactor). Panel and box are to be sheet steel construction, with see-through steel-framed acrylic door and trim, handle and lock. Enclosure protection IP 42 to IEC 60947-1 for indoor installation and IP 55 for outdoor installation.

G. Weatherproof Switch (S15): 10 A, 250 V, for installation outdoors, and indoor wet areas with weatherproof plate, synthetic gasket, weatherproof outlet box, on/off indication, IP 56 enclosure.

H. Double Pole Switch (S20): Rated 20 A (or as shown on the Drawings), 250 V a.c., tumbler operated, to IEC 60669-1, with stainless steel or molded plastic plate (as required in application area), marked (etched) with equipment controlled (i.e. cooker, air conditioner, water heater) and with red neon pilot light for "on" position. Switch is to be mounted to flush or surface box, as required or as shown on the Drawings, and provided with cord outlet and cord extension to equipment controlled.

I. Manual Switch (S25): 2 pole, for fractional single phase motors and appliances, to interrupt motor and induction loads, rated 30 A at 240 V a.c., and 20 A at 600 V a.c., toggle operated, with positive indication of on/off position of contacts.

110.040 SOCKET OUTLETS

A. Generally: To have injection molded plastic base with self-adjusting, non-expanding contacts to prevent permanent distortion, arranged for side and/or back connection and with screw terminals accepting at least three parallel branch-circuit wires.

B. Types: General-purpose socket outlets are to conform to standard SASO and British practice and BS standard 1363

C. Duplex sockets are to be mounted in parallel under one common plate with break-off feature for two-circuit connection.

D. Weatherproof socket outlets are to be any of the types indicated, enclosed in surface mounted cast metal box and with cover comprising spring-retained gasket hinged flap. Enclosure is to be pre-designed box and cover for type of socket outlet specified.

E. Standard British Socket Outlet - Type R01 (230 V SERVICE): To BS 1363, polarized, grounding type, with three rectangular pin-holes (two poles and earth), rated 13 A, 250 V, switched, switched, recessed, brushed stainless steel.
   1. .Location: All front-of-house, and as shown on drawings

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F. Standard British Socket Outlet - Type R03 (230 V SERVICE): To BS 1363, polarized, grounding type, with three rectangular pin-holes (two poles and earth), rated 13A, 250 V, switched, with robust shutter mechanism operated by earth pin, Thermoplastic with glossy finish with white plastic cover plate and inserts.
   1. Location: All back-of-house areas and back-of-house offices, and as shown on drawings.

G. Standard British Socket Outlet - Type R04 (230 V SERVICE): To BS 1363, polarized, grounding type, with three rectangular pin-holes (two poles and earth), rated 13A, 250 V, switched, surface mounted, metal clad, aluminum finish with white insert and switch

   1. Location: Technical areas, electrical/telecom rooms, and as shown on drawings.

H. Weatherproof Socket Outlet - Type R05 (230 V SERVICE): 13A, 250 V, 2 pole plus earth, to BS 1363, switched, enclosed in surface mounted cast-metal box and with cover comprising spring-retained gasket hinged cover. IP 56.
   1. Location: Mechanical rooms, and as shown on drawings.

I. Standard British Socket Outlet - Type R06 (230 V SERVICE): Similar to R01, but with duplex.
   1. Location: All front-of-house areas, and as shown on drawings

J. Standard British Socket Outlet - Type R08 (230 V SERVICE): Similar to R03, but with duplex.
   1. Location: All back-of-house areas and back-of-house offices, and as shown on drawings.

K. Standard British Socket Outlet - Type R09 (230 V SERVICE): Similar to R04, but with duplex.
   1. Location: Technical areas, electrical/telecom rooms, and as shown on drawings.

L. Standard British Socket Outlet - Type R11 (230 V SERVICE): Similar to R01, but with red rocker, Fed from UPS.

M. Standard British Socket Outlet - Type R13 (230 V SERVICE): Similar to R03, but with red rocker, Fed from UPS.

N. Standard British Socket Outlet - Type R14 (230 V SERVICE): Similar to R04, but with red rocker, Fed from UPS

O. Standard British Socket Outlet - Type R15 (230 V SERVICE): Similar to R05, but with red rocker, Fed from UPS

P. Standard British Socket Outlet - Type R16 (230 V SERVICE): Similar to R06, but with red rocker, Fed from UPS.

Q. Standard British Socket Outlet - Type R18 (230 V SERVICE): Similar to R08, but with red rocker, Fed from UPS.

R. Standard British Socket Outlet - Type R19 (230 V SERVICE): Similar to R09, but with red rocker, Fed from UPS

S. Power Socket - Type R31: Single outlet, single phase, three wire, 16A, weatherproof (IP 44) power switched socket outlet, 16A used in Kitchen and Laundry areas, indoors.
   1. Ref: K9913 BLU or other approved equal

T. Power Socket - Type R32: Single outlet, single phase, three wire, 32A, weatherproof (IP 44) power switched socket outlet, 16A used in Kitchen and Laundry areas, indoors.
   1. Ref: K9643 BLU or other approved equal

U. Power Socket - Type R41 Single outlet, single phase, three wire, 16 A, 2P+E, 250 V, to IEC 60309, polarized with L-shaped earth contact, splash proof molded cast metal plate and matching plug. Sockets used for car charging or similar applications shall be twist-lock type.

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V. Power Socket - Type R42: Single outlet, single phase, three wire, 32 A, 2P+E, 250 V, to IEC 60309, polarized with L-shaped earth contact, splash proof molded cast metal plate and matching plug. Sockets used for car charging or similar applications shall be twist-lock type.
   1. Man: Legrand
   2. Ref: 059243

W. Industrial Socket Outlet - Type R45: single outlet, 3P+E, 3 phase, polarized, earthing type, rated 32 A, 400/415 V, to IEC 60309, with splash proof cast metal box and hinged spring-return plate, and with matching plug 3P+E.

X. Shaver Socket - Type R55: Specially designed for use with electric shavers, incorporating dual voltage isolating transformer 110/230 V and voltage selector switch. Socket is to be universal type, accepting round pin (Continental) and flat pin (American) plugs with disconnecting switch to isolate transformer from supply. Transformer is to be protected by over-current, self-resetting thermal device. Socket is to be molded plastic with flush plate marked with available voltage and function of both selector and disconnecting switches.

110.050 METALLIC OUTLET BOXES

A. Recessed and Concealed Boxes: galvanized pressed steel, with knock-outs for easy field installation. Special boxes are to be punched as required on Site.

B. Exposed Surface Mounted Boxes: galvanized cast iron with threaded hubs.

C. Outdoor Surfaces or Recessed Boxes: galvanized cast iron with threaded hubs and PVC gaskets to ensure water tightness and with stainless steel or non-ferrous, corrosion resistant screws.

D. Floor Boxes - Type A: watertight, cast iron or cast metal alloy with corrosion resistant finish, adjustable mounting, standard duty, round or square, factory drilled and tapped for required conduit sizes, and with brass cover and flange with brushed finish free from markings other than required for mounting screws.

E. Floor Boxes - Type B: non-standard size, flush floor mounted, cast metal alloy, with watertight neoprene gasketed and hinged cover, and with drilled and tapped conduit entries and adjustable mounting. Metal barriers are to separate services for power and low current.

F. Flame Proof Boxes: malleable iron or cast iron, with gas threaded hubs, special covers with silicon rubber gaskets, gas tight, and water-tight. Boxes are to comply with the Regulations for explosive areas.

G. Manufacturers: obtain metallic outlet boxes from same manufacturer as conduit or other approved, and to the satisfaction of the Engineer

Floor Box Type	Electrical	Telecom	Remarks
FB1	1 UPS Duplex R18	2 Data Outlet	SELF CHECK IN KIOSK, BPV, E-GATES, FIDS-1S, XRAY HAND BAGGAGE
FB2	1 UPS Simplex R13	2 Data Outlet	METAL DETECTOR, ETD, WHOLE BODY IMAGER (IF Any)

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FB3	1 UPS Simplex R13 + 1 UPS Duplex R18	2 Data Outlet	FIDS-2F/FIDS IT
FB4	2 UPS Duplex R18	4 Data Outlet	FIDS-1D, FIDS 1S
FB5	1 UPS Duplex R18	1 Data Outlet	FIDS-2G
FB6	1 Normal Duplex	1D	IPTV Floor mounted
FB7	1 Normal Duplex R08	2D	Advertisement Screens
FB8	2 UPS Duplex R18, 1 Normal Duplex R08	3D	For Immigration counters
Floor Outlets Type	**Electrical**	**Telecom**	
FO1	1 Normal Duplex R08	-	AUTOMATIC TRAY RETURN
FO2	1 UPS Duplex R18	-	

110.060 PLUGS

A. Type: Compatible with type of socket outlet specified, break resistant, of impact resistant molded insulating material (separable construction), with solid brass pins and cord grip and of shape Providing Easy Hand-Grip For Removal.

B. Quantity: Supply number equal to 20% of total number of each type of socket outlet supplied.

110.070 SPECIAL DEVICES

A. Lighting Contactors

1. Type: Double pole for single phase and neutral circuits, and triple or four-pole for three phase circuits, mechanically held, electrically operated, rated 500 V, of current ratings shown on the Drawings, and complying with the appropriate category of IEC 60947-4-1 Table 1.
2. Contacts: Copper alloy, with silver cadmium alloy double break contacts designed for switching inductive ballast loads and switching of tungsten lamp loads.
3. Auxiliary Contacts: As required to provide specified interlocks and signals as shown on the Drawings, or required by the Specification, with one N.O. and one N.C. spare contacts.
4. Enclosure: Unless forming part of system housed in sheet steel panel, contactor is to be provided with IP 42 enclosure for indoor use or IP 65 enclosure for outdoor use.
5. Control: Each contactor whether part of a system or separately enclosed is to have on/off pilot lights and set of on/off push buttons mounted on cover.

B. Photoelectric Cells

1. Photoelectric Cells: Omnidirectional cadmium sulfide, hermetically sealed, with 2:1 on/off adjustment possible by moving light level selector, set to operate at illuminance levels shown on the Drawings. Unit is to include timer giving 3-minute delay to prevent false switching. Temperature range is to be -10 deg. C to +80 deg. C.
2. Safety: Control is to be designed such that in case of failure, unit fails in the on position.
3. Contacts are to close or open as illumination level increases to set level with respect to requirements shown on the Drawings.

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4. Enclosure: Heavy duty cast metal, with translucent dome of 'Lexan' (by G.E.) or other equal and approved, to protect against high ultra violet rays, and 180 deg. swivel base and 16 mm threaded conduit mounting. Enclosure is to be weatherproof and protected against high winds and storms.

C. Time-Switch

1. Type And Rating: Clock is to be escapement mechanical type, electrically rewound, with 24 hours dial and time adjustment and rated 10 A, 250 V.
2. Spring reserve mechanism is to allow up to 12 hours operation in the event of power failure.
3. Switching is to be capable of performing two on and two off operations, adjustable, over 24 hours.
4. Manufacturers: Obtain time-switch from:

D. Remote Lighting Relay Control System

1. Remote Lighting Relay Panel (RLRP): Comprise set of heavy duty long life service relays, rated 20 A, 230 V a.c. for switching tungsten or fluorescent lighting loads, SPST maintained (mechanically latched), with 24 V a.c. split-coil (1/2-on and 1/2-off) for control by remote push button on/off switches, via 24 V control transformer.
2. Push Button Switch (LS): SPDT, momentary contact, normally open switch with pilot light and red jewel Lens, Rated 3 A, 25 V A.C.
3. Master Selector Switch Panel (MSSP): Comprise set of push button switches type (LS), assembled in one unit comprising box and cover, with individual switch per circuit controlled, and one master switch for all-circuit control.
4. System is to allow local and remote centralized switching of group of lighting circuits and from any number of individual points. System is to use low voltage (low current) control circuitry to operate relay switches on branch circuits.
5. Manufacturers: System is to be by G.E. Remote Control Products or other equal and approved.

E. Contactor Control Panels In Connection With CCMS

1. General: Control panels are to be of equivalent construction to panel boards with respect to cabinet and interior standards of manufacture, and are to be surface mounted with see-through door and lock.
2. Construction: Non-standard modular, factory assembled cabinets, designed to receive appropriate contactors, measuring devices, terminals, relays and the like as required in conformity with the Drawings for operation of system locally and remotely from central control and monitoring system (CCMS) console.
3. Control: Switching relays controlled remotely by the CCMS are to be provided with over-riding manual local individual controls. Appropriate interface components are to be provided and coordinated with the CCMS described elsewhere in the Specification.
4. Relays, switching components, pilot lights, control transformers, fuses etc. are to be neatly arranged and mounted inside dust-tight and, where necessary, water-tight cabinets. Control and indication devices are to be continuously visible and accessible for monitoring and control.
5. Equipment is to be electrically front shielded and enclosed by sheet metal barriers, readily accessible and demountable. Wiring is to be neatly arranged, clipped and terminated in pressure type terminals. Hardware is to be non-corroding and robust material, approved by the Engineer.
6. Control panels are to incorporate three ammeters, one per phase for local readings.
7. Current transformers are to have auxiliaries to enable connection to CCMS.
8. Contactors are to be of the appropriate category, Table 1 to IEC 60947-4-1 generally as described under paragraph 110.070 A hereof. Each contactor is to be protected by an equally rated circuit breaker of suitable short-circuit capacity at point of application.
9. Overcurrent relay is to be provided with all other accessories. Upon detecting fault on monitored control panel, corresponding plug-in breaker unit is to trip, and fault signal is to be sent to CCMS.
10. Instrument and instrument transformers are to be provided as required and/or as indicated on the Drawings.
11. Current Transformers: Bar primary type to IEC 60044-1 class 0.5 for metering. Current rating is to be the next higher standard value above maximum demand load current.

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12. Ammeters and Voltmeters: Long scale, switchboard type, with shadow proof covers for semi-flush mounting. Meters are to be approximately 100 mm square with scale covering approximately 250 degrees.
13. Voltmeter Selector Switches: Rotary type with cam operated contacts, and having 7 positions (off, R-Y, Y-B, B- R, R-N, Y-N, B-N).
14. Test blocks and plugs are to be provided for testing all instruments and instrument transformers.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and Division A Specification Sections, apply to this Section.

210.000 RELATED SECTIONS

A. Division V Section "Basic Electrical Materials and Methods".

B. Division Y Section "Raceways and Boxes for Electrical Systems" for boxes.

PART 3 PRODUCTS AND WORKMANSHIP

300.000 MATERIALS

300.010 MANUFACTURERS

A. Approved Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

1. Schneider Electric
2. Schneider Electric / Square D
3. MK/Honeywell
4. Legrand
5. G.E.

300.020 PRODUCTS

A. Products: Subject to compliance with requirements, provide one of the products indicated for each designation AS shown on plans.

310.000 QUALITY MANAGEMENT

310.010 QUALITY ASSURANCE

A. Comply with related Standards.

310.020 SPARE PARTS AND EXTRA MATERIAL

A. Furnish 2 % (with minimum of one each) extra materials for all products that match those installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Employer.

320.000 SUBMITTALS

A. Technical Data: Submit data for approval, including catalogues, detailed literature, manufacturer's name, catalogue number, rating, specification, overall dimensions and special features, as applicable for each item.

B. Shop and Construction Drawings: Submit drawings for approval including, but not limited to, the following:

1. Exact indication of position of each item and outlet box and fitting on layout drawings, with box and equipment types and sizes.

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2. Installation details of special devices including fans etc.
3. Wiring diagrams of special items.

C. Samples: Submit samples of each type of device for approval, unless otherwise agreed in writing by the Engineer.

D. Maintenance Data: For materials and products to include in maintenance manuals specified in Division 1.

330.000 EXECUTION

330.010 INSTALLATION

A. Locations: Drawings generally show approximate locations of outlets and equipment. Exact locations are to be determined from interior finishing and detail drawings. Any condition that would place an outlet in an unsuitable location is to be referred to the Engineer. Locate switches at strike sides of doors, whether shown on the Drawings or not. In locating outlets allow for overhead pipes, ducts, variations in arrangement, thickness of finishing, window trim, paneling and other engineering features.

B. Mounting heights for outlet boxes and similar equipment are to be uniform within the same or similar areas. Mounting is to be as shown on the Drawings or as approved by Engineer. Unless otherwise shown or instructed, mount lighting switches and socket outlets generally at 1200 mm and 300 mm from finished floor level respectively. Mount switches with long dimension vertical and operating handle, if of the toggle type, up when in the on position.

C. Additional outlets to those shown on the Drawings are to be provided as required by equipment manufacturers for control or other wiring.

D. Recessed Outlet Boxes: Make neat openings, to the satisfaction of the Engineer, allowing for thickness of finishing, and use extension rings if required. Repair damaged finishing to original condition before installation of fittings or plates.

E. Appearance: Install exposed boxes and plates plumb, square and parallel to finished wall surface. Exposed plates covering recessed boxes are to rest neatly on wall surface without gaps, and fully covering the box.

F. Grouped Outlets: Arrange neatly so that use of fittings is convenient and clear.

G. Waterproof and Explosion-Proof Fittings: Follow manufacturer's instructions for installation and connection to conduit system to fully achieve required degree of protection.

H. Damaged Fittings: Reject damaged fittings or plates with damaged finish. Protect fittings and plates against damage after installation and until handed over.

330.020 IDENTIFICATION

A. Comply with Division V Section "Basic Electrical Materials and Methods."

1. Switches: Where three or more switches are ganged, and elsewhere as indicated, identify each switch with approved legend engraved on wall plate.
2. Receptacles: Identify panel board and circuit number from which served. Use machine-printed, pressure-sensitive, abrasion-resistant label tape on face of plate and durable wire markers or tags within outlet boxes.

330.030 CONNECTIONS

A. Single pole switches are to switch the phase wire. Do not run neutral wire through switches having neutral shunt or bridge.

B. Exposed Outlet Boxes: Securely fasten to wall with machine screws to permanent inserts or lead anchors.

C. Connection Of Appliances:

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D. Where appliance is designed to adapt directly to outlet box, extend electrical wiring to incoming terminals inside appliance.

E. Where appliance is not designed to adapt to outlet box, install the connecting wiring in flexible conduit firmly fixed to outlet box cover plate and to terminal box on appliance.

F. Tighten electrical connectors and terminals according to manufacturers published torque-tightening values.

330.040 FIELD QUALITY CONTROL

A. Visual Inspection: Fittings and equipment are to be inspected for fixing and workmanship.

B. Megger tests are to include switch and socket outlet tests together with insulation resistance of wiring installations.

C. Operation: Devices are to be tested for operation and are to perform as intended at full load without any signs of heating.

D. Equipment is to be insulation tested and observed, under full-load for not less than 3 days operation, with respect to undue heating and performance in general.

330.050 CLEANING

A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

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V72 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. This Section includes individually mounted enclosed switches and circuit breakers used for the following:

1. Service disconnecting means.
2. Motor and equipment disconnecting means.

Components are to be standard manufactured items, uniform and modular, complying with one set of approved Standards.

110.000 SYSTEM DESCRIPTION

110.010 SWITCH DISCONNECTOR (DISCONNECTING SWITCH)

A. Type: Heavy duty, non-fused, air break, single throw, 600-V AC, suitable for motor circuits or for service entrance disconnecting applications, 2, 3, 4 or 6 poles as shown on the drawings. Disconnecting switches shall comply with IEC 60947-3, with ampere rating as shown on the Drawings ensuring its suitability for equipment horsepower rating where disconnecting switch is used for switching motors or other highly inductive loads.

B. Design: Safety type, housed in separate metallic enclosure with arc quenching devices on each pole.

C. Short Circuit Withstand: Switch disconnectors shall be capable of withstanding the maximum short circuit current at the point of installation in combination with the upstream protective device.

D. Operating Handle: A suitable handle made of conducting material shall be provided for safety and convenient operation of the switch and it shall be in electrical connection with the enclosure. In case the position of the switch contacts is indicated by the position of the operating handle, then there shall be definite off and on indicated positions for the handle, and the design of the operating mechanism shall be such that the handle cannot be left readily at or near the off position when the switch is on. A handle indicating the position of the switch contacts either closed or open shall be designed such that the door cannot be closed and secured in place with the handle indicating off while the switch contacts are in the on position.

E. Operating Mechanism: Quick-make, quick-break, double contact rotary blade mechanism, independent manual operation. The design of the operating mechanism in conjunction with the contact structure shall be such that, in normal operation, the persons operating the switch cannot restrain the operations of the contacts after they have initially touched or parted when closing or opening the switch. The design and construction of the operating mechanism shall assure ample strength and rigidity. Screws and nuts serving to attach operating parts to cross bars or other movable members shall be upset or otherwise locked to prevent loosening under the jarring of continued use. Stops shall be provided as necessary to remove undue strain from switch parts. Materials shall be suited for the particular application. Contacts and terminals shall be made of tin plated copper of 99.5% purity.

F. Mechanical Interlock: the box, cover and switch operating mechanism shall be mechanically interlocked so that the door is normally prevented from being opened when the switch contacts are in the closed position and the switch contacts are normally prevented from being closed when the door is open. Switch disconnector shall be provided with a defeatable interlock by which a qualified person using the necessary tools can open the door while the switch is in the on position or close the contacts when the door is open. Interlock shall be reactivated automatically when the enclosure door is closed.

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G. Padlocking: Means shall be provided for padlocking enclosures shut, they shall be provided to positively lock the switch with the contacts in the off position with a padlock and shall accommodate at least three padlocks. Any single padlock shall be capable of providing locking.

H. Switch Disconnectors for Variable Frequency Drive (VFD) Motors: Switch Disconnectors connected to VFD motors shall have an auxiliary contact that interfaces with the motor's VFD to switch off the VFD drive before disconnecting the motor.

I. Enclosure: Enclosures shall be made of steel material, properly anti-corrosion treated and electrostatic coated unless otherwise specified. Enclosures shall comply with IP 20 to IEC 60529 for indoor general use installations, IP 54 to IEC 60529 for indoor industrial / mechanical rooms installations, IP 65 to IEC 60529 with stainless grade 304 for indoor wet areas; such as kitchen, laundry and hospital's central sterile supply department (CSSD) and clean rooms, and IP65 to IEC 60529 and to be suitable for outdoor installations, unless otherwise required or shown on the Drawings. Enclosures shall be used with the appropriate conductor entry fittings; such as knockouts and bolt on hub kit in order to maintain the specified environmental capability after installation.

J. Terminals: A switch shall have suitable wiring terminals for connection of conductors having an ampacity not less than the switch's current rating for only current rated switches.

K. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

110.020 ENCLOSED CIRCUIT BREAKERS

A. Enclosed Circuit Breaker Rated up to 1250 A shall have same specification of DP as specified in Division Y Section "Panelboards".

B. Enclosed Circuit Breaker Rated above 1250 A shall have same specification of switchboards as specified in Division Y Section "Switchboards".

110.030 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosures before shipping.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and Division A Specification Sections, apply to this Section.

210.000 RELATED SECTIONS

A. Related Sections include the following:

1. Division V Section "Basic Electrical Materials and Methods".
2. Division V Section "Wiring Devices" for attachment plugs, receptacles, and toggle switches used for disconnecting means.
3. Division Y Section "Switchboards" for circuit breakers.

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PART 3 PRODUCTS AND WORKMANSHIP

300.000 MATERIALS

300.010 MANUFACTURERS

A. Approved Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

1. Cutler-Hammer/Eaton Corp.
2. GE
3. ABB
4. Schneider Electric / Square D

310.000 QUALITY MANAGEMENT

310.010 QUALITY ASSURANCE

A. Disconnecting switches in compliance with IEC 62626-1 and IEC 60947-3, equipped with metallic enclosure and ample space to accommodate both incoming and outgoing cables.

310.020 DELIVERY, STORAGE AND HANDLING

310.030 WARRANTY

A. Manufacturer’s Warranty: Submit a written warranty signed by the manufacturer agreeing to repair, restore or replace any defective equipment specified in this section during the specified warranty period

1. Warranty Period: 1 year from date of Substantial Completion.

320.000 SUBMITTALS

A. Technical Data: Submit data for approval, including catalogues, detailed literature, manufacturer's name, catalogue number, rating, specification, overall dimensions and special features, as applicable for each type of switch, circuit breaker, accessory, and component indicated.

B. Shop and Construction Drawings: Submit drawings for approval including, but not limited to, the following:

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:

a) Enclosure types and details.
b) Current and voltage ratings.
c) Short-circuit current rating.
d) Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
e) Cable terminal size.

2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.

C. Field Test Reports: Submit written test reports and include the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.
4. Samples: Submit samples of each type of equipment for approval, unless otherwise agreed in writing by the Engineer.

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5. Operation and Maintenance Data: For enclosed switches and circuit breakers and for components to include in maintenance manuals specified in Division A. In addition to requirements specified in Division A Section "Closeout Procedures," include the following and to the satisfaction of Employer's requirements:

    a) Routine maintenance requirements for components.
    b) Manufacturer's written instructions for testing and adjusting switches and circuit breakers.
    c) Time-current curves, including selectable ranges for each type of circuit breaker.

330.000 EXECUTION

330.010 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance.

    1. Proceed with installation only after unsatisfactory conditions have been corrected.

330.020 INSTALLATION

A. Locations: Drawings generally show approximate locations of equipment. Exact locations are to be determined from detail drawings. Any condition that would place equipment in an unsuitable location is to be referred to the Engineer.

B. Waterproof Fittings: Follow manufacturer's instructions for installation and connection to conduit system to fully achieve required degree of protection.

C. Damaged Equipment: Reject damaged equipment. Protect equipment against damage after installation and until handed over.

D. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

E. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

330.030 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division V Section "Basic Electrical Materials and Methods."

B. Enclosure Nameplates: Label each enclosure with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

330.040 CONNECTIONS

A. Install equipment grounding connections for switches and circuit breakers with ground continuity to main electrical ground bus.

B. Install power wiring. Install wiring between switches and circuit breakers, and control and indication devices.

C. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

330.050 FIELD QUALITY CONTROL

A. Visual Inspection: Equipment is to be inspected for fixing and workmanship.

B. Operation: Devices are to be tested for operation and are to perform as intended at full load without any signs of heating.

C. Prepare for acceptance tests as follows:

    1. Test insulation resistance for each enclosed switch, circuit breaker, component, and control circuit.

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2. Test continuity of each line- and load-side circuit.

D. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in the relevant standards. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
3. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

E. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

F. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

330.060 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges to fulfill the coordination study requirements.

330.070 CLEANING

A. On completion of installation, inspect interior and exterior of enclosures. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

330.080 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the conditions specified in Division V Section “Basic Electrical Materials and Methods.”

330.090 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

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W10A - IP-BASED TELEPHONY COMMUNICATIONS SYSTEM

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. Section includes a carrier grade IP-based Telephony Communications System consisting of central switching equipment and telephone instruments as such:

1. Call Processing Unit and software.
2. Gateways.
3. Signaling Servers.
4. IP terminals and client devices.
5. Applications and network management.

100.020 PERFORMANCE REQUIREMENTS

A. Refer to Division W, Section “Data Communications”.

B. Software Requirements

1. To be developed.

C. Design Considerations

1. To be developed.

D. Software Expansion Requirements

1. To be developed.

E. Hardware Expansion Requirements

1. To be developed.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Refer to Division W Section “Common Clauses for IT & Security Systems”.

110.020 PROJECT/SITE CONDITIONS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

110.030 DEFINITIONS AND ABBREVIATIONS

A. Refer to Division W Section “Common Clauses for IT & Security Systems”.

B. Definitions

1. “OFE”: shall refer to “Owner Furnished Equipment”, which will be provided by the Owner/Employer. The Contractor shall be responsible for removing this equipment from the Owner’s premises and re-installing and integrating this equipment in good working order where required and detailed in these Specifications.
2. "Turnkey System": a complete system of hardware and software delivered to the Employer ready-to-run.

C. Abbreviations: To be developed.

120.000 SYSTEM DESCRIPTION

120.010 SCOPE OF WORK

A. Refer to Division W Section “Common Clauses for IT & Security Systems”.

120.020 SYSTEM DESCRIPTION

A. Overview of Current Environment and Requirements

B. General Features

1. The IP-Based Telephony System shall provide centralized communications to deliver voice and other services as defined within the scope of works.
2. The system shall be an extension of the current IP-Based Telephony System currently operational at other Airport facilities.
3. The Telephone System connectivity shall utilize the Airport Operational Network and communications cabling supporting infrastructure.

130.000 CONTROL REQUIREMENTS

130.010 INTEGRATION REQUIREMENTS

A. To be developed.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. General

1. Refer to Division W Section W31 “Common Clauses for IT & Security Systems”.

B. Related Sections

1. To be developed

210.000 RELATED PRODUCTS

210.010 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

PART 3 PRODUCTS AND WORKMANSHIP

300.000 PRODUCTS

300.010 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but not limited to:

1. To be developed

B. Adjunct Systems

1. Where adjunct systems are not available directly from the selected Telephony System manufacturer, adjunct manufactures must be certified or otherwise approved for use by the selected Telephony System manufacturer.

C. End Point Devices

1. Where endpoint devices are not available directly from the selected Telephony System manufacturer, end point devices must be certified or otherwise approved for use by the selected Telephony System manufacturer.

300.020 SYSTEM ARCHITECTURE

A. The Contractor shall provide a full description of the proposed system architecture.

B. The Contractor shall include diagrams explaining system architecture and shall specify the model names and version numbers of all relevant components of the system.

C. The solution shall:

D. be able to integrate with radio trunking, public access, and paging systems and any other system, e.g. DECT, GSM, WiFi, etc.

E. be centralized into Main Telecom Rooms from a call processing and signaling perspectives. All VoIP/TDM conversion devices (Media Gateways) shall be located within telecommunication spaces.

F. support multi-Manufacturer interoperability with other Manufacturer's products and across any QoS infrastructure.

G. support end-to-end QoS, including but not limited to traffic marking, enhanced queuing services, link fragmentation and interleaving, CRTP, low latency queuing, link efficiency, traffic shaping, and call admission control.

H. provide bandwidth management and call admission control to guarantee at all times that the network and LAN/WAN links are not over-subscribed.

I. be able to support open industry standard devices such as H.323, SIP, etc., including the support of analog and digital phones.

J. support remote office phones from a centralized phone system. The Contractor shall state any additional equipment that maybe required at the remote site.

K. have local survivability capabilities provided for remote sites during a WAN outage (for remote sites hosted off of a central server).

L. be able to provide easy addressing scheme of the IP phones, such as Dynamic Host Control Protocol (DHCP), without having to change the addressing scheme of the existing IP data network.

M. The Telephony system shall provide redundant server based call processing, Internet Protocol / Time Division Multiplexing (IP/TDM) media gateways, redundant server based multi-media UM, auto attendant, Automatic Call Distributor (ACD), VoIP telephones, analog telephones, wireless Local Area Network (LAN) telephones, thin client software telephones, dedicated network switches, other end devices, hardware, software, programming, configuration, wire, system patch panels, terminations, patch cords and including all accessories required for a complete and operating system.

N. The Telephony System shall include High-Availability platform with built in self diagnostics and self-healing capabilities to provide 99.999% reliability for all call processing and all call routing systems.

O. The Telephony System shall utilize redundant distributed call processors, with redundant power supplies, redundant connectivity and automatic load balancing.

P. The Telephony System shall be capable of non-blocking VoIP operation, peer-to-peer IP connectivity, with active monitoring and control for the duration of all calls.

Q. Telephony System ports, licenses and configurations shall be provided for each end device and connection as applicable.

R. Re-homing of VoIP Telephones subsequent to loss of any component shall be automatic and not impact the dial plan, features, or capabilities. All services shall be automatically restored, without intervention when the failed condition has been corrected.

S. System Administration shall be Graphical User Interface (GUI) based and integrated to allow basic telephone system Moves, Adds and Changes (MACs) including UM to be automatically configured in each other system to eliminate the need for duplicate manual updating of other systems. A scheduling feature is to be provided for telephone MACs and software backup processing.

T. The Telephony System shall be equipped with basic ACD capabilities and reporting with the following basic functions.

U. Automatic routing of calls based on caller menu choices and agent availability.

V. Interface with Interactive Voice Response (IVR) system.

W. The Telephony System shall provide capability to send immediate audio page to groupings of telephone sets by building.

X. The Telephony System shall provide encryption capability and be secured from hacking attempts and unauthorized access.

Y. The system shall support all relevant industry standards listed below.

Z. Manufacturers shall be compliant as a minimum with the following standards. Update as appropriate to conform to latest applicable standards.

AA. Class Based Weighted Fair Queuing (CBWFQ).

BB. Committed Access Rate.

CC. Compressed Real Time Protocol (CRTP).

DD. DCL.

EE. Dynamic Host Configuration Protocol (DHCP).

FF. Differentiated Services.

GG. Domain Name Service (DNS).

HH. FAX - Group 3 (ITU-T recommendation T.4 Fax group 3 is the most common type of fax machine transmitting on A4 paper. The machine scanning format is digital and operates at rates between 9.6 and 14.4 Kbps).

II. FAX - Group 4 (IUT-T recommendation T.6 and supports two-dimensional image compression, compressing the line width as well as the line length).

JJ. G.711 Pulse Code Modulation (PCM) of Voice Frequencies.

KK. G.726 Adaptive Differential Pulse Code Modulation (ADPCM).

LL. G.728 Coding of Speech at 16 Kbps using Low-Delay Algebraic Code Excited Linear Prediction (LD-ACELP).

MM. G.729 Coding of Speech at 8 Kbps using Conjugate Structure Algebraic Code Excited Linear Prediction (CS-ACELP).

NN. G.729a Annex A Reduced Complexity 8 Kbps CS-ACELP Speech Codec.

OO. H.225 Call Signaling Protocols and Media Stream Packetization for Packet based Multimedia.

PP. H.245 Control Protocol for Multimedia Communications.

QQ. H.323 Packet Based Multimedia Communication Systems.

RR. IP Precedence.

SS. Internet Protocol version 6 (IPv6).

TT. Lightweight Directory Access Protocol (LDAP).

UU. Media Gateway Control Protocol (MGCP).

VV. Policy Based Routing.

WW. Q.931 Manages Call Setup and Termination.

XX. Priority Queue Weighted fair Queuing (PQWFQ).

YY. Random Early Discard (RED).

ZZ. Resource ReSerVation setup Protocol (RSVP).

AAA. RTP Control Protocol (RTCP).

BBB. Real-time Transport Protocol (RTP).

CCC. Real-time Streaming Protocol (RTSP).

DDD. Session Initiation Protocol (SIP).

EEE. T.120 Data Protocols for Multimedia Conferencing.

FFF. Simple Network Management Protocol (SNMP).

GGG. Transmission Control Protocol / Internet Protocol (TCP/IP).

HHH. T.37.

III. T.38 IP Based Fax Service Maps.

JJJ. User Datagram Protocol / Internet Protocol (UDP/IP).

KKK. Voice Profile for Internet Mail (VPIM).

LLL. Weighted Queuing.

MMM. Weighted RED.

NNN. IEEE 802.1d Spanning Tree Protocol.

OOO. IEEE 802.1p Prioritization Technique/Layer 2 QoS.

PPP. IEEE 802.1q VLAN Tagging.

QQQ. IEEE 802.3 Ethernet (CSMA/CD).

RRR. IEEE 802.3af Power over Ethernet.

SSS. IEEE 802.1x

300.030 SYSTEM RELIABILITY, SECURITY AND AVAILABILITY

A. To be developed

B. Refer to Division W, Section "Common Clauses for IT & Security Systems"

300.040 TELEPHONY SYSTEM CAPABILITIES

A. The following performance parameters shall not be exceeded for end to end communications.

1. To be developed

B. To be developed

300.050 TELEPHONY SYSTEM CAPACITY

A. Equipment Quantity Definitions

1. Installed: The quantity or capacity of an item required to be operational at cut over.
2. Equipped: The quantity or capacity of an item required to be resident in the system at cut over for immediate activation.
3. Wired: The capability or quantity of an item that can be realized by adding plug-in components (e.g., line cards, trunk cards, and station equipment) at any time in the future without installing additional cabinets, modules, shelves, common equipment or memory.

B. Spare Capacity

1. To be developed

C. Installed Quantity Sizing for End Devices

1. To be developed

D. Installed Quantity Sizing for Service Provider Connections

1. To be developed

300.060 TELEPHONY SYSTEM CONFIGURATION

A. To be developed

300.070 TELEPHONE REQUIREMENTS

A. As a minimum, the VoIP devices/server, software and handsets shall be required to support the following industry based, standard protocols and specifications:

1. To be developed

300.080 CALL PROCESSING SYSTEM

300.090 PUBLIC MEDIA GATEWAYS

300.100 IP TERMINALS AND CLIENT DEVICES

A. Station Hardware and IP Softphone

B. Indoor telephone sets shall comply with the following unless otherwise noted:

C. Analog telephone for harsh environment shall have the following characteristics:

1. To be provided

D. Wall mounted IP telephones shall have the following additional characteristics:

1. To be provided

E. Standard IP telephones shall have the following characteristics:

1. To be provided

F. Enhanced IP telephones shall have the following characteristics:

1. To be provided

G. Wireless IP telephone shall have the following characteristics:

1. To be provided

H. Conference IP telephone shall have the following characteristics:

1. To be provided

I. Cordless IP telephone shall have the following characteristics:

1. To be provided

J. Telecommunications Devices for the Deaf (TDD) shall have the following characteristics:

1. To be provided

K. IP Payphones shall have the following characteristics:

1. To be provided

L. Dual Band Wireless IP telephone shall have the following characteristics:

1. To be provided

M. Contact Center Agent IP telephone

1. To be provided

300.110 APPLICATIONS

A. Voice Mail and Unified Messaging System

B. IP Contact Center

C. Conferencing

D. Web Collaboration Functionality

300.120 CALL ROUTING AND REPORTING SOFTWARE FUNCTIONALITY

300.130 DIAL PLAN AND ADVANCED ROUTING FEATURES

300.140 INTERACTIVE VOICE RESPONSE (IVR) AND COMPUTER TELEPHONY INTEGRATION (CTI)

300.150 DIGITAL AUDIO RECORDING

300.160 SYSTEM ADMINISTRATION REQUIREMENTS

300.170 SYSTEM MONITORING AND DIAGNOSTICS

300.180 CALL ACCOUNTING / CALL LOGGING

300.190 NETWORK MANAGEMENT SYSTEM

300.200 INTERCONNECTION AND THIRD PARTY NETWORK SERVICES

300.210 OTHER CAPABILITIES

310.000 QUALITY MANAGEMENT

310.010 PRODUCTS AND WORK BY OTHERS / COORDINATION

1. To be provided

310.020 CONFIDENTIALITY

A. Refer to Division W Section “Common Clauses for IT & Security Systems”.

310.030 QUALITY ASSURANCE

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Licensing Requirements

1. To be provided

310.040 DELIVERY, STORAGE AND HANDLING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

310.050 WARRANTY

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

310.060 COMMISSIONING

1. To be provided

310.070 MAINTENANCE AND SUPPORT DURING WARRANTY PERIOD

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

310.080 SPARE PARTS AND EXTRA MATERIAL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be provided

320.000 SUBMITTALS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

1. To be provided

330.000 EXECUTION

330.010 INSTALLATION

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

330.020 FACTORY ACCEPTANCE TESTS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

330.030 FIELD QUALITY CONTROL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be provided

330.040 DEMONSTRATION AND TRAINING

A. To be provided

W10C - IP-BASED TELEVISION SYSTEM (IPTV)

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. Section includes an IP-Based Television System accessed from networked computers and from set-top boxes. The system shall be capable of providing the following services via an IP-based streaming media system over Ethernet:

1. Satellite television
2. Digital terrestrial Off-air television
3. Broadcast video /Cable Television
4. Pay-per-view
5. Internet connectivity
6. Video on Demand (VOD)
7. Interactive TV standard features.

100.020 PERFORMANCE REQUIREMENTS

A. The IPTV System shall be delivered free of engineering, manufacturing, installation and operating defects. The system shall be engineered and installed for ease of operation, maintenance and testing.

B. The IPTV system shall be designed with the greatest level of resiliency and redundancy based on functional and technical design requirements.

C. The system shall be modular to allow future expansion without the introduction of major changes.

D. To be developed.

E. The IPTV system shall support the following functional requirements.

1. Overall system consistent latency shall be less than 200ms**.**
2. Overall system jitter shall be less than 50ms.
3. Individual alphanumeric number codes shall be assigned to each IPTV set-top box.
4. Language selection shall be flagged at default, as per Employer requirements, and shall be user selectable.
5. Service access levels shall be assigned, including child lock and use of pin codes.
6. All transactions shall be logged in a secured database.
7. All defaults shall be reset and user related data shall be erased upon user subscription deletion.
8. All alarm conditions shall be reported to the server.
9. Interactive Middleware shall be capable of operating continuously in standalone mode whereby all transactions will be logged.

F. The system shall display 100 channels with the capacity to expand to 200channels in the future.

G. The following sources shall be used for the system:

1. satellite, including all Free-to-Air channels and Non-Free-to-Air packages channels.
2. Off-air [Digital Terrestrial] [UHF/VHF] Local channels
3. International News Channels CNN, Fox News, BBC-Arabic, BBC-English, Al-Arabiya, etc..
4. Video streaming of Cable TV signals or previously stored data.

H. Expansion capability:

1. 25%spare capacity is required at all levels of the system.
2. The software licensing shall be for the entire system with no limitation on the number of end-users.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Codes and Standards: All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

C. Antenna reception and distribution systems: "Cable networks for television signals, sound signals and interactive services":

1. EN 60728-1: Part 1: System performance of forward paths
2. EN 60728-1-1: Part 1-1: RF cabling for two way home networks
3. EN 60728-1-2: Part 1-2: Performance requirements for signals delivered at the system outlet in operation
4. EN 60728-3: Part 3: Active wideband equipment for cable networks
5. EN 60728-4: Part 4: Passive wideband equipment for coaxial cable networks
6. EN 60728-5: Part 5: Headend equipment
7. EN 60728-6: Part 6: Optical equipment
8. EN 60728-10: Part 10: System performance for return paths
9. EN 60728-11: Part 11: Safety
10. EN 50083-2: Part 2: Electromagnetic compatibility for equipment
11. CLC/TR 50083-5-1: Part 5-1: IP gateways and interfaces for headends
12. EN 50083-8: Part 8: Electromagnetic compatibility for networks
13. EN 50083-9: Part 9: Interfaces for CATV/SMATV headends and similar professional equipment for DVB/MPEG-2 transport streams

D. Safety regulations such as earthing, lightning protection, potential equalization, mechanical stability, etc.

1. EN 60728-11: Part 11: Safety.

E. Regulations pertaining to EMC interference emission/irradiation, short-circuit current, interference suppression, etc.

1. EN 50083-2: Part 2: Electromagnetic compatibility for equipment
2. EN 50083-8: Part 8: Electromagnetic compatibility for networks

F. Standard overview of "coaxial cables" for cable distribution systems to EN 50117:

1. EN 50117-1: Part 1: Generic specification
2. EN 50117-2-1: Part 2-1: Sectional specification for cables used in cabled distribution networks - Indoor drop cables for systems operating at 5 MHz - 1000 MHz
3. EN 50117-2-2: Part 2-2: Sectional specification for cables used in cabled distribution networks - Outdoor drop cables for systems operating at 5 MHz - 1000 MHz
4. EN 50117-2-3: Part 2-3: Sectional specification for cables used in cabled distribution networks - Distribution and trunk cables for systems operating at 5MHz - 1 000 MHz
5. EN 50117-2-4: Part 2-4: Sectional specification for cables used in cabled distribution networks - Indoor drop cables for systems operating at 5 MHz - 3000 MHz
6. EN 50117-2-5: Part 2-5: Sectional specification for cables used in cabled distribution networks - Outdoor drop cables for systems operating at 5 MHz - 3000 MHz
7. EN 50117-2-6: Part 2-6: Sectional specification for CATV cables up to 6 GHz used in cabled distribution networks
8. EN 60966-2-4: Part 2-4: Radio Frequency and coaxial cable assemblies - Part 2-4: Detail specification for cable assemblies for radio and TV receivers - Frequency range 0 MHz to 3000 MHz, IEC 61169-2 connectors .

G. Comply with FAA AC 70/7460-1 or ICAO ANNEX 14, VOL.1 for marking and lighting of antenna installations.

H. All Audiovisual equipment (such as TV sets) shall be "ENERGY STAR qualified" products or equivalent international certification program wherever possible. They shall carry the latest applicable version of ENERGY STAR label or equivalent.

I. The system functions in public areas such as elevators and lobbies shall comply with the most current version of the Accessibility Guidelines by Authorities Having Jurisdiction.

110.020 PROJECT/SITE CONDITIONS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

110.030 DEFINITIONS AND ABBREVIATIONS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Definitions

1. Pay-Per-View: Similar to pay-per-view services of existing cable TV services. User has no control over playback and feature presentation time.
2. Near Video on Demand: Allows the viewer to choose viewing time within specified limits. Groups sessions of the same movie together in multicast sessions. Fast Forward and rewind are implemented by jumping between multicasts.
3. True Video on Demand: Full choice of viewing times with VCR type controls. Dedicates an entire session to a single user and provides individualized user control over the presentation.
4. User Interface: End point of Contractor's responsibility for Work of this Section. User interfaces are the RJ45 terminals on device plates (system outlets).
5. MPEG-4 Part 10: video compression standard, also known as MPEG-4 AVC (for Advanced Video Coding) and equivalent to H.264 of ITU-T.
6. MPEG-H Part 2: video compression standard, also known as HEVC for High Efficiency Video Coding and equivalent to H.265 of ITU-T.

C. Abbreviations

1. To be developed

120.000 SYSTEM DESCRIPTION

120.010 SCOPE OF WORK

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed.

120.020 SYSTEM DESCRIPTION

A. The IPTV system shall consist of the following main components:

1. Integrated Receiver/Decoder (IRD)
    a) To be developed
2. HD and SD Processor/Streamer
    a) To be developed
3. Audio/Video Monitor
    a) To be developed
4. Video-On-Demand Server/Multimedia Server
    a) To be developed
5. Encoding Station
    a) To be developed
6. Middleware server
    a) To be developed
7. System Controller PC: IPTV Supervision Workstation
    a) To be developed

8. IPTV configured network switches
    a) To be developed
9. Satellite dish antenna
    a) To be developed
10. DiSEqC™ Multi-switch
    a) To be developed
11. VHF/UHF Antenna
    a) To be developed
12. DVB-T Receiver
    a) To be developed
13. IPTV Set-Top Boxes
    a) To be developed
14. Equipment racks
    a) To house the head-end equipment.
15. Cables
    a) To be developed

120.030 DESIGN REQUIREMENTS

A. To be developed

120.040 INTERACTIVE TV SYSTEM FEATURES

A. To be developed

130.000 CONTROL REQUIREMENTS

130.010 INTEGRATION REQUIREMENTS

A. The IPTV System shall be integrated and interfaced to the following systems. The Contractor shall coordinate with the Employer to clearly define the scope of work for system interfacing and shall identify those areas requiring interface work by third party suppliers.
    1. To be developed

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. General
    1. Refer to Division W, Section W31 “Common Clauses for IT & Security Systems”.
B. Related Sections
    1. To be developed

210.000 RELATED PRODUCTS

210.010 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

210.020 SIGNAL TRANSMISSION COMPONENTS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

210.030 CONDUITS, TRUNKING, ENCLOSURES AND FITTINGS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

PART 3 PRODUCTS AND WORKMANSHIP

300.000 PRODUCTS

300.010 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but not limited to:

1. To be developed

300.020 IPTV SYSTEM HEADEND COMPONENTS

A. Multi-format SD/HD Integrated Receiver / Decoder

1. To be developed

B. HD/SD Video Processor/Streamers

1. To be developed

C. Audio and HD Video Monitor

1. To be developed

D. Encoding station

1. To be developed

E. Video on Demand (VOD) Server/ Multimedia Server

1. To be developed

F. Middleware Application

1. To be developed

G. Minimum requirements of Supervision Workstation and associated peripherals shall be confirmed by relevant manufacturer/supplier and shall comply with:

1. Division W, Section “Computers & Related Peripherals”.

H. To be developed

300.030 SET-TOP BOX

A. The set-top box (STB) shall be the hardware and common software infrastructure component that will be employed at the end user premises to convert video, delivered as IP packets, into an uncompressed digital stream that can be directly turned into TV signal ready for display by a television set.

B. The set-top box shall be capable of supporting advanced IPTV functionality such as Digital Video Recorder (DVR), allowing the user to rewind, fast-forward, pause, slow down play, etc. by sending user commands upstream via the channel.

C. To be developed

300.040 OFF-AIR AND SATELLITE TV RECEPTION

A. Comply with the relevant requirements and recommendations of EN 50083 series and EN 60728 series “Cable Networks for Television Signals, Sound Signals and Interactive Services” for satellite and digital terrestrial TV reception at headend.

B. Coaxial cables used for satellite and digital terrestrial TV reception at headend shall comply with the relevant requirements and recommendations of EN 50117 series "Coaxial Cables”.

C. To be developed

D. Antenna Tower: To be developed

E. Off-Air, Mast-Mounted Antennas (DVB-T Terrestrial Antennas, where required): To be developed .

F. Satellite Earth-Station Antenna: To be developed

G. Universal receiving system Ku-Band: To be developed

H. Universal receiving system Ku-Band: To be developed

I. DiSEqC™ Multiswitch: To be developed

J. DVB-T Receiver: To be developed

K. Coaxial Cables: To be developed.

310.000 QUALITY MANAGEMENT

310.010 PRODUCTS AND WORK BY OTHERS / COORDINATION

A. Contractor shall coordinate with the Employer and his Suppliers when considering:

1. Structured communications system cabling, termination, identification and testing.
2. Provision and installation of computer hardware, racks/cabinets and related networking software and equipment.
3. Active communication and data processing equipment.
4. Fiber optic cabling infrastructure.
5. Provision and installation of a Virtualized Servers Environment.
6. Provision and installation of UPS in communications rooms.
7. Communications grounding busbars and grounding wires connecting to the main building earth electrode system.
8. Dedicated power panels, ground busbars, circuits, floor boxes and utility outlets.
9. Installation and finishing of plywood backboards.
10. Building mechanical ductwork, cooling/heating system and environmental control sensors.
11. Communications pathway devices such as cable trays, conduits, conduit sleeves, and penetrations in walls and floors.

B. To be developed

310.020 MISCELLANEOUS QUALITY MANAGEMENT TOPICS

A. For the following quality management topics, refer to Division W, Section “Common Clauses for IT & Security Systems”:

1. CONFIDENTIALITY
2. QUALITY ASSURANCE
3. DELIVERY, STORAGE AND HANDLING
4. WARRANTY
5. COMMISSIONING
6. MAINTENANCE AND SUPPORT DURING WARRANTY PERIOD

310.030 SPARE PARTS AND EXTRA MATERIAL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

320.000 SUBMITTALS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

330.000 EXECUTION

330.010 INSTALLATION

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

330.020 FACTORY ACCEPTANCE TESTS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

330.030 FIELD QUALITY CONTROL

A. To be developed

330.040 DEMONSTRATION AND TRAINING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

W12A - IP-BASED PUBLIC ADDRESS SYSTEM

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. Section includes a fully IP-network based Public Address and Voice Alarm System (PA/VA), for the purpose of voice evacuation, emergency notification, paging, BGM and messaging**.**

B. The PA/VA System shall constitute a Voice Evacuation System/ Voice Alarm Communication System (EVC) which is independent of but collocated and interfaced with the Fire Detection and Alarm System.

C. The PA/VA system shall interface with the FAS and other ELV Building Services Systems. These interfaces shall be hardwired where required by code.

100.020 PERFORMANCE REQUIREMENTS

A. Basic emergency functions performance criteria.

B. Non-emergency functions performance criteria.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Codes and Standards: All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. Equipment and system shall comply with the following Standard:

a) BS EN 54-16, Fire detection and fire alarm systems. Components for fire alarm voice alarm systems. Voice alarm control and indicating equipment.
b) BS EN 54-24, Fire detection and fire alarm systems. Requirements for the design and construction of loudspeakers.
c) BS EN 54-4, Fire detection and fire alarm systems. Power supply equipment.
d) BS 5839 Part 8, Fire detection and fire alarm systems for buildings. Code of practice for the design, installation, commissioning and maintenance of voice alarm systems.
e) BS 6259, Code of practice for the design, planning, installation, testing and maintenance of sound systems.
f) BS EN 50849, Sound systems for emergency purposes.
g) IEC 60268 (BS 6840) (series, as applicable), Sound system equipment
h) ISO 8240-16, Fire detection and alarm systems, Part 16: Sound system control and indicating equipment
i) BS EN ISO 3382-1, Acoustics. Measurement of room acoustic parameters. Part 1 Performance spaces.
j) BS EN ISO 3382-2, Acoustics. Part 2 Measurement of room acoustic parameters. Reverberation time in ordinary rooms.
k) BS EN ISO 3382-3, Acoustics. Part 3 Measurement of room acoustic parameters. Open plan offices.

2. System Network:

a) The PA/VA System shall be based on IEEE 802.3bt PoE Ethernet Network Infrastructure. All network cabling, conventions and equipment shall be consistent with this IEEE standard.
b) Comply with the latest issue of several material and test standards, which have been developed and published by Institute of Electrical and Electronics Engineers (IEEE) for data communications industry, but not limited to:
c) IEEE 802.1 – LAN/MAN Bridging and Management,
d) IEEE 802.3 – Carrier Sense Multiple Access/Collision Detection Access Methods (Ethernet),

e) IEEE 802.11 – Carrier Sense Multiple Access/Collision Avoidance Access Methods (Wireless LAN's),
f) ISO/IEC/IEEE 24765, Systems Software Engineering Vocabulary.
g) Comply with the latest issue of several Network Equipment Building System (NEBS) material and test standards, which have been developed and published by Telcordia (Ericsson). Level 1, Level 2, and Level 3 are applicable to this Section:
h) SR-3580: NEBS™: Criteria Levels.
i) GR-63: NEBS Requirements: Physical Protection.
j) GR-1089: Electromagnetic Compatibility (EMC) and Electrical Safety - Generic Criteria for Network Telecommunications Equipment.
k) GR-3160-Core: Generic requirements for Data Centers Equipment and Spaces.

3. For interface with the Fire Alarm System, comply with the latest issue of:

a) BS 9999 and BS 5839 recommendations

4. Fire rated Cable Certified for 120 minutes

a) EN 50200, Method of test for resistance to fire of unprotected small cables for use in emergency circuits
b) UL 2196, Standard for Fire Test for Circuit Integrity of Fire-Resistive Power, Instrumentation, Control, and Data Cables
c) BS 8434-2, Methods of test for assessment of the fire integrity of electric cables. Test for unprotected small cables for use in emergency circuits. BS EN 50200 with a 930° flame and with water spray.
d) BS 7629-1, Electric cables. Specification for 300/500 V fire resistant screened cables having low emission of smoke and corrosive gases when affected by fire. Multicore and multipair cables.
e) BS 6387, Test method for resistance to fire of cables required to maintain circuit integrity under fire conditions.
f) IEC 60331-1, Tests for electric cables under fire conditions.
g) IEC 60331-2, Tests for electric cables under fire conditions.
h) IEC 60332-2-2, Tests on electric and optical fibre cables under fire conditions.
i) IEC 60332-3-10, Tests on electric and optical fibre cables under fire conditions.
j) IEC 60331-2, Tests for electric cables under fire conditions.
k) UL 1724, Outline of Investigation for Fire Tests for Electrical Circuit Protective Systems.
l) UL 1685, Standard for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables.
m) UL 1666, Test for Flame Propagation Height of Electrical and Optical- Fiber Cables Installed Vertically in Shafts.

5. The system functions in public areas such as lifts (elevators), lobbies and parking areas shall comply with the Accessibility Guidelines by Authorities Having Jurisdiction.
6. Local regulations and standards, where enforced and relevant, are to have precedence over the Standards.
7. To be developed.

110.020 PROJECT/SITE CONDITIONS

A. Refer to Division W, Section "Common Clauses for IT & Security Systems".

110.030 DEFINITIONS AND ABBREVIATIONS

A. Refer to Division W, Section "Common Clauses for IT & Security Systems".

B. Definitions

1. Channels: Separate parallel signal paths, from sources to loudspeakers or loudspeaker zones, with separate amplification and switching that permit selection between paths for speaker alternative program signals.
2. Zone: Separate group of loudspeakers and associated supply wiring that may be arranged for selective switching between different channels.

C. Abbreviations:

1. To be developed

120.000 SYSTEM DESCRIPTION

120.010 SCOPE OF WORK

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

120.020 SYSTEM DESCRIPTION

A. Overview

1. The PA/VA system shall be used in case of fire detection to help speed up response time and advise occupants of the safest emergency route.
2. During a fire incident, a pre-recorded message shall be broadcast providing a clear instruction of what action to take.
3. It shall be possible for the PA/VA system to provide emergency messages in incidents other than fire.
4. Retain Sub-paragraph below for multiple occupancy buildings or large buildings with a complex fire strategy.
5. The PA/VA system shall provide phased evacuation for the Project.
6. Pre-recorded messages will be specifically generated as per the requirements of each site, to assist in safe evacuation.
7. Voice alarm messages shall be in multiple languages in an accent which is familiar and intelligible to the people of UAE, which is a cosmopolitan with more than 165 nationals living in the country.

B. Basic Emergency Functions

1. The PA/VA system shall be used for:

a) Live emergency paging
b) Timed security messages
c) Coded staff alert messages

2. In case of Fire Detection, Emergency Voice Evacuation or Communication System in Positive Alarm Sequence (Delayed Alarm sequence) shall be permitted.

C. Non-Emergency Functions

1. In addition to Voice Alarm, the PA/VA system shall be used for ancillary functions such as:

a) General paging
b) Advertising announcements
c) Background music (BGM)
d) Passenger announcement systems (mass transportation hubs)
e) Call to prayer

2. These ancillary functions shall not impair the required operation of the emergency voice evacuation or communications system.

D. General Features

1. The PA/VA system shall be BS EN 54-16, ISO 7240-16 and EN/IEC 50849 certified and BS 5839 part 8 compliant, with:

a) Full system supervision
b) Loudspeaker line impedance supervision
c) A supervised emergency microphone on the front panel and
d) A supervised message manager for the pre-recorded messages and chimes.
e) The PA/VA system components shall communicate over IP.
f) The PA/VA system shall utilize an Audio over IP (AoIP) protocol that supports AES67 for audio and AES70 for control with encryption and authentication.

E. Message Priorities

1. Signals associated with life safety
2. Signals associated with property protection
3. Trouble signals associated with life and/or property protection
4. All other signals

F. System Location

1. The PA/VA system main controller and system amplifiers shall be provided next to fire alarm control panel (MFACP/FACP), at a continuously monitored location, which is attended by facility management or designated personnel at all times, such as Command Center, etc.

G. To be developed.

130.000 CONTROL REQUIREMENTS

130.010 INTEGRATION REQUIREMENTS

A. To be developed

PART 2

PART 3 REFERENCES

300.000 RELATED DOCUMENTS

A. General

1. Refer to Division W, Section W31 “Common Clauses for IT & Security Systems”.

B. Related Sections

1. To be developed.

310.000 RELATED PRODUCTS

310.010 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

310.020 SIGNAL TRANSMISSION COMPONENTS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

310.030 CONDUITS, TRUNKING, ENCLOSURES AND FITTINGS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

310.040 ARCHITECTURAL FITTINGS, FINISHES AND BRACKETS

A. To be developed.

PART 4 PRODUCTS AND WORKMANSHIP

400.000 PRODUCTS

400.010 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

1. To be developed .

400.020 GENERAL FEATURES

A. To be developed.

400.030 SYSTEM COMPONENTS

A. The PA/VA system shall consist of several integrated sub-systems that form a complete system for building announcement and message management:

1. The system shall consist of:

a) Controller
b) Amplifiers
c) Call stations
d) Sound sources
e) Loudspeakers
f) Power supply
g) Inter-cabling
h) Accessories such as end-of-line modules
i) Workstations, servers and other hardware and software requirements
j) Equipment racks, housing the system headend equipment.

400.040 GENERAL EQUIPMENT AND MATERIAL REQUIREMENTS

A. To be developed.

1.

400.050 TECHNICAL STUDY

A. Preliminary Study

1. To be developed.

B. Final Study

1. To be developed.

400.060 IP-NETWORKED CONTROLLER

400.070 IP-NETWORKED CALL STATION

400.080 IP-NETWORKED MULTI-CHANNEL AMPLIFIER

A. ETHERNET SWITCH

1. The Ethernet switch shall be a managed ten (10) -port Industrial Gigabit switch with:
2. eight (8) RJ45 ports providing PoE and
3. two (2) ports providing RJ45/SFP combo sockets for glass fiber transceivers.
4. RS-232 serial interface for console.

400.090 FIBER TRANSCEIVERS

A. LX Fiber transceiver

B. SX Fiber transceiver

400.100 IP-NETWORKED MULTI-FUNCTION POWER SUPPLY

A. The multi-function power supply shall provide a fully supervised DC-power supply with integrated fail-safe redundancy.

400.110 AUXILIARY DC POWER SUPPLIES

400.120 LOUDSPEAKERS

A. General Characteristics:

1. Voice alarm loudspeakers shall be listed and approved by UAE Civil Defence and they shall be tested as part of the voice evacuation system.

B. DSP Controlled Line Arrays

C. Loudspeaker Type 1: 20-Watt Ceiling Speaker

D. Loudspeaker Type 2: 6-Watt Ceiling Speaker

E. Loudspeaker Type 3: 6-Watt Cabinet /Wall Mounted Speaker

F. Loudspeaker Type 4: 20-Watt Wall Mounted Speaker

G. Loudspeaker Type 5: 20-Watt Ceiling Mounted Pendant Speaker

400.140 REMOTE WALL-MOUNTED VOLUME CONTROLLER

400.150 NETWORK EQUIPMENT

400.160 INTEGRATION REQUIREMENTS

400.170 UNINTERRUPTIBLE POWER SUPPLY (UPS)

400.180 SIGNAL TRANSMISSION COMPONENTS

400.190 CONDUITS, TRUNKING, ENCLOSURES AND FITTINGS

400.200 ARCHITECTURAL FITTINGS, FINISHES AND BRACKETS

400.210 PROPOSED SOLUTION

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed.

410.000 QUALITY MANAGEMENT

410.010 PRODUCTS AND WORK BY OTHERS / COORDINATION

A. To be developed

410.020 MISCELLANEOUS QUALITY MANAGEMENT TOPICS

A. For the following quality management topics, refer to Division W, Section “Common Clauses for IT & Security Systems”:

1. CONFIDENTIALITY
2. QUALITY ASSURANCE
3. DELIVERY, STORAGE AND HANDLING
4. WARRANTY
5. COMMISSIONING
6. MAINTENANCE AND SUPPORT DURING WARRANTY PERIOD

410.030 SPARE PARTS AND EXTRA MATERIAL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

420.000 SUBMITTALS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Samples for initial selection:

1. To be developed

C. Additional Requirements for Shop Drawings

1. To be developed

D. Calculations:

1. To be developed

E. Coordination Drawings:

1. To be developed

430.000 EXECUTION

430.010 INSTALLATION

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Open-Cable Installation

1. To be developed

C. Impedance and Signal Levels

1. To be developed

430.020 FACTORY ACCEPTANCE TESTS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

430.030 FIELD QUALITY CONTROL

A. To be developed

430.040 OCCUPANCY ADJUSTMENTS

A. To be developed

430.050 DEMONSTRATION AND TRAINING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

W12F - IP-BASED INTERCOM SYSTEM

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. Section includes state-of-the-art, electronic Security Audio Communication system that enables IP-based intercommunications, access control, monitoring and protection of all pertinent areas of the Project facilities.

B. The terms “Security Audio Communication system”, “IP-based Intercom system” and “IP-enabled Intercom system” are equivalent and may be used interchangeably throughout this Specification.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. System peripheral components and devices shall comply with the requirements of:

1. EN 50486, Equipment for use in audio and video door-entry systems.
2. Or other approved international standard.

C. The system functions in public areas such as lifts (elevators), lobbies and parking areas shall comply with the most current version of the Accessibility Guidelines by Authorities Having Jurisdiction.

110.020 PROJECT/SITE CONDITIONS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

110.030 DEFINITIONS AND ABBREVIATIONS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Definitions

1. To be developed.

120.000 SYSTEM DESCRIPTION

120.010 SCOPE OF WORK

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed.

C. Other Clarifications Related to the Scope of Work:

D. The IP-based Intercom system shall utilize the Project Structured Cabling Network and Data Communications Network Installations. This connectivity shall form part of the Structured Cabling Network and Data Communications Network as applicable. It shall not form part of the Intercom system.

E. Network switches and other similar devices which are strictly dedicated and configured for the Intercom system, but installed remotely from the Intercom headend, shall form part of the work for the Intercom system.

F. Inter-wiring, conduits and related accessories, network connectivity and any other material which is specific to the Intercom central equipment and which is required to provide a complete operational system, shall form part of the Intercom system.

120.020 SYSTEM OVERVIEW

A. The IP-enabled Intercom System shall consist of a Security Audio Communication Node/Exchange and various types of intercom stations distributed at key locations throughout the Project and connected to the Project Data Communications Network.

1. Audio Servers: To be developed
2. Master Stations: To be developed
3. Control Room Station: To be developed.
4. Substations, Wall Mount: To be developed
5. Substations, Weatherproof and Vandal proof: To be developed

B. To be developed.

C. The Security Audio Communication Node shall provide seamless integration with the following systems:

1. Public address system.
2. VOIP telephone system and public telephone network.
3. Parking Control Equipment.

D. System design shall take into consideration Project requirements in terms of end users special needs, regulations, system planning, operation, changes and maintenance.

E. The Security Audio Communication system shall utilize the Project Data Communication Network and shall support:

1. Network monitoring servers
2. Network time servers
3. E-mail notification
4. Remote system programming
5. Remote system upgrade

130.000 CONTROL REQUIREMENTS

130.010 INTEGRATION REQUIREMENTS

A. The IP-based Intercom System shall be integrated and interfaced to the following systems:

1. To be developed.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. General

1. Refer to Division W, Section W31 “Common Clauses for IT & Security Systems”.

B. Related Sections

1. To be developed

210.000 RELATED PRODUCTS

210.010 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

210.020 SIGNAL TRANSMISSION COMPONENTS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

210.030 CONDUITS, TRUNKING, ENCLOSURES AND FITTINGS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

PART 3 PRODUCTS AND WORKMANSHIP

300.000 PRODUCTS

300.010 MANUFACTURERS

1. To be developed

300.020 PROPOSED SOLUTION

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Data Transmission:

1. To be developed

C. General

1. System Architecture shall be based on a "Client-Server" configuration.
2. System software shall be controlled and configured by working parameters stored in tables and easy to change without programming.
3. The Audio Server / Security Audio Communication Node shall support networking for Analogue Intercom Stations, IP-based Intercom Stations, Analogue telephones and SIP-based telephones.
4. The system shall be capable of automatic duplex hands-free operation without the use of handsets, at both the initiating station and the receiving station.
5. To be developed

D. System Software

1. To be developed

E. Critical Communications Over IP (CCoIP®)

1. To be developed

F. Performance Criteria

1. To be developed

300.030 NETWORK EQUIPMENT

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

300.040 SYSTEM OPERATION

A. Master-To-Master Calls

1. To be developed

B. Call From Security Substations To Control Room Master Station

1. To be developed

C. Call From a Control Room Master Station to Any Other Station

1. To be developed

D. Group Call from a Control Room Master Station

1. To be developed

E. Programming Buttons on the Control Room Master Station

1. To be developed

F. Control Desk PC Managing Program

1. To be developed

300.050 EQUIPMENT

A. Stations

1. Standard Master Stations
2. Control Room Master Station
3. Substation, Wall-Mount
4. Weather and Vandal Resistant Substations

B. Other System Components include;

1. To be developed

300.060 STANDARD SYSTEM FEATURES

A. To be developed

310.000 QUALITY MANAGEMENT

310.010 PRODUCTS AND WORK BY OTHERS / COORDINATION

A. To be developed

310.020 MISCELLANEOUS QUALITY MANAGEMENT TOPICS

A. For the following quality management topics, refer to Division W, Section “Common Clauses for IT & Security Systems”:

1. CONFIDENTIALITY
2. QUALITY ASSURANCE
3. DELIVERY, STORAGE AND HANDLING
4. WARRANTY
5. COMMISSIONING
6. MAINTENANCE AND SUPPORT DURING WARRANTY PERIOD

310.030 SPARE PARTS AND EXTRA MATERIAL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

320.000 SUBMITTALS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

330.000 EXECUTION

330.010 INSTALLATION

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

330.020 FACTORY ACCEPTANCE TESTS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

330.030 FIELD QUALITY CONTROL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

330.040 OCCUPANCY ADJUSTMENTS

A. To be developed

330.050 DEMONSTRATION AND TRAINING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

W12H - MASTER CLOCK SYSTEM (MCS)

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. Section Includes:

1. A GPS and An Ethernet Synchronized master clock system using NTP and POE.
2. NTP clocks.
3. Interfaces with other systems.
4. System wire and cable.

100.020 PERFORMANCE REQUIREMENTS

A. NTP (Network Time Protocol) servers with an integrated GPS receiver located on a LAN (Local Area Network) shall provide the high accuracy of the GPS satellite system of the UTC reference time. The system shall utilize the existing Project Local Area Network to provide a synchronized clock display system.

B. Time Server Accuracy:

1. Stratum 1, NTP V2, V3, V4.

C. 1PPS output ±50 nanoseconds of UTC time reference provided by the NTP server(s), when synchronized.

D. Internal oscillator/10MHz (battery backed real-time clock circuit during GPS /Ethernet loss):

1. TCXO (temperature compensated crystal oscillator): 1x10–11 over 24 hours to GPS, 1x10-8 aging/day, 450 usec 1PPS holdover in 24 hours or,
2. OCXO (oven-controlled crystal oscillator): 2x10-12 over 24 hours to GPS, 5x10-10 aging/day, 25 usec 1PPS holdover in 24 hours.

E. Security Features

1. The system shall support the following features, as a minimum, for improved security and quality of service (QoS) for real time processing and network management: IPv6 address standard, SSL (Secure Sockets Layer) and SSH (Secure Shell).

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Specific reference in specifications to codes, rules, regulations, standards, manufacturer’s instructions, or requirements of regulatory agencies shall mean reference to the latest printed edition of each.

C. All equipment shall be tested, labelled and certified by an internationally recognized and approved testing laboratory to meet the following performance specifications, electromagnetic compatibility and safety requirements (European Standards):.

1. Electromagnetic Compatibility Directive: (EMC) 2014/30/EU.
2. Safety: European Low voltage directive (LVD): 2014/35/EU [**Or**] BS EN 62368-1, Audio/video, information and communication technology equipment. Safety requirements
3. European Radio Equipment Directive (RED) 2014/53/EC.
4. ITU-T Standards:

a) G.703, Physical/Electrical Characteristics of Hierarchal Digital Interfaces
b) G.704, Synchronous Frame Structures Used at 1544, 6312, 2048, 8488, and 44736kbps Hierarchical Levels

c) G.810, Definitions and Terminology For Synchronized Networks
d) G.811, Timing Characteristics of Primary Reference Sources
e) G.812, Timing Requirements for Slave Clocks for use as Node Clocks in Synchronized Networks
f) G.813, Timing Characteristics of SDH Equipment Slave Clocks
g) G.824, Control of Jitter and Wander Within Digital Networks That are Based on the 1544kbps Hierarchy

110.020 PROJECT/SITE CONDITIONS

A. Refer to Division W, Section "Common Clauses for IT & Security Systems".

110.030 DEFINITIONS AND ABBREVIATIONS

A. Refer to Division W, Section "Common Clauses for IT & Security Systems".

B. Definitions

1. GPS: Global Positioning System: A worldwide system that employs 24 orbiting satellites in an integrated network to determine geographic location anywhere in the world, and which employs and transmits atomic time.
2. UTC: Universal time coordinated. A time-scale that forms the basis of a coordinated distribution of standard frequencies and time signals throughout the world. It is often referred to as Greenwich Mean Time (GMT).
3. Ethernet synchronized master clock system: Provides time synchronization via SNTP (Simple Network Time Protocol) or Daytime Protocol from time server. The clock system controller receives the same time via an Ethernet connection, which is then transmitted to the network clocks. This requires a TCP/IP Network with Internet access or connection to a Network Time Server.
4. PRS: Primary Reference Source.; provides Stratum-1 quality output signal (ANSI terminology); also known as PRC: Primary Reference Clock (ITU-T terminology).

120.000 SYSTEM DESCRIPTION

120.010 SCOPE OF WORK

A. Refer to Division W, Section "Common Clauses for IT & Security Systems".

B. To be developed

C. Other Clarifications Related to the Scope of Work:

1. The master clock system shall utilize the Project Structured Cabling Network and Data Communications Network Installations. This connectivity shall form part of the Structured Cabling Network and Data Communications Network as applicable. It shall not form part of the Clock System.
2. Network switches and other similar devices which are strictly dedicated and configured for the Master Clock System, but installed remotely from the system controller, shall form part of the works for the Clock System.
3. Inter-wiring, conduits and related accessories, network connectivity and any other material which is specific to the central equipment and which is required to provide a complete operational system, shall form part of the Clock System.

120.020 SYSTEM DESCRIPTION

A. This Section specifies a wired clock system that relies on a connection with the Global Positioning Satellite (GPS) system and Ethernet for synchronizing the time provided to clocks and network devices using the Network Time Protocol (NTP).

B. Data and low voltage DC power shall be distributed over the same network cable using Power over Ethernet (PoE) technology.

C. To be developed

D. NTP (Network Time Protocol) servers shall allow clients which may be supplied by different manufacturers to synchronize clocks, computer clocks, other computer timing devices and other kinds of network equipment using the standard reference of time accepted worldwide, known as UTC (Universal Time Coordinated).

E. The clock system shall be operated within the parameters of a standard network configuration, and shall utilize standard industry network equipment and distribution methods, including standardized PoE distribution technology.

F. The clock system shall operate autonomously and shall provide software configuration options for time zone offsets, automatic daylight saving time corrections without scheduled operator intervention or maintenance. The clock system shall be configured via software control and shall allow for remote monitoring and configuration changes while providing password protection.

G. Configuration Software

1. The network clock system shall be fully configurable and managed remotely through IP via software.

H. GUI Interface – Windows configuration

1. The network clock system shall include a GUI (Graphical User Interface) based network software application, operating under the Windows OS, for configuration and maintenance of the network time server and all network clocks.
2. The GUI application shall include password protection of the clock configuration, encrypted communication, and the ability to enable or disable options that might reduce security.
3. A status display to remotely monitor the time displayed on the clock, the internal UTC time, synchronization status, and any error condition regarding the clocks network status shall be provided and for quickly configuring groups of clocks with the ability to save and load configurations.

I. Console interface – Unix/Linux, non-Windows platform configuration:

1. A separate menu driven Telnet or SSH (Secure Shell) console interface shall be provided for configuration, of the network time server and network clocks on a non-Windows OS such as UNIX, Linux.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. General

1. Refer to Division W, Section W31 “Common Clauses for IT & Security Systems”.

B. Related Sections

1. To be developed

210.000 RELATED PRODUCTS

210.010 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

210.020 SIGNAL TRANSMISSION COMPONENTS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

210.030 CONDUITS, TRUNKING, ENCLOSURES AND FITTINGS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

PART 3 PRODUCTS AND WORKMANSHIP

300.000 PRODUCTS

300.010 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but not limited to:

1. To be developed

300.020 SYSTEM FUNCTIONS AND FEATURES

A. To be developed.

300.030 MASTER CLOCK

A. Description: Microprocessor-based, software-controlled unit.

1. Programming and control switches.
2. Informational Display: LED or backlit LCD type.

a) Normally shows current time, display.

b) Provides programming cues when system is being programmed.
c) Provides all international time zones.

3. Data Output Port for interface with the Internet and the Local Area Network.
4. Power Supplies: To be developed.
5. Enclosure: To be developed.
6. Housing: To be developed.
7. Electrostatic Discharge Resistance: To be developed.

300.040 NTP CLOCKS

A. To be developed

B. NTP Clock Characteristics – Analog Type:

1. To be developed

C. NTP Clock Characteristics – Digital Type:

1. To be developed

300.050 BACK BOXES FOR NTP CLOCKS

A. To be developed

300.060 GUARDS

A. To be developed

300.070 GPS ANTENNA

A. To be developed

310.000 QUALITY MANAGEMENT

310.010 PRODUCTS AND WORK BY OTHERS / COORDINATION

A. To be developed

310.020 CONFIDENTIALITY

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

310.030 QUALITY ASSURANCE

A. To be developed

310.040 DELIVERY, STORAGE AND HANDLING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

310.050 WARRANTY

A. To be developed

310.060 COMMISSIONING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

310.070 MAINTENANCE AND SUPPORT DURING WARRANTY

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

310.080 SPARE PARTS AND EXTRA MATERIAL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

320.000 SUBMITTALS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Additional Requirements for Submittals:

1. Product data: To be developed
2. Shop Drawings: To be developed
3. Samples for Initial Selection: To be developed
4. Operating License for the GPS transmitter (if required by local regulations and Authorities Having Jurisdiction): To be developed

330.000 EXECUTION

330.010 INSTALLATION

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

330.020 FACTORY ACCEPTANCE TESTS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

330.030 FIELD QUALITY CONTROL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

330.040 ADJUSTING

A. Program system according to Employer's requirements.

B. To be developed

330.050 DEMONSTRATION AND TRAINING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

W12J - DISTRIBUTED ANTENNA SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions apply to this Section.

B. This specification is to be used as a basis for the system design which includes installation and performance criteria. The Contractor shall finalize the system design according to the proposed approved products that shall be used to validate the design. The Contractor shall present in his shop drawings the final solution based on the selected and approved materials, in compliance with the standards, rules, and regulations stipulated in these specifications. The scope shall also include verification and coordination of the final solution to the satisfaction of the Employer and the Engineer.

1.2 SUMMARY

A. The below specification section is performance based.

B. Final specifications and GSM related products selection shall be as per the mobile operator requirements and recommendations.

C. The specified Distributed antenna system (DAS) shall provide complete coverage throughout the project scope. Two separate systems shall be provided:
   1. The cellular system shall be provided by mobile operators.
   2. The Tetra system shall be provided by the contractor and shall allow communication between staff that are constantly moving throughout the building for operation, maintenance, security and safety purposes.

D. The system components of the TETRA system include, but are not limited to, the following:
   1. Optical Master Unit,
   2. Optical Remote Unit,
   3. Coaxial cables, splitters, couplers, amplifiers, and ancillary distribution components,
   4. Indoor antennas,
   5. Terminations, connectors, and ancillary components,
   6. Wireways and cable containment system,

E. Single mode fiber optic cabling to support connectivity between the headend master equipment, any intermediate fiber optic distribution units, and to remote antenna unit equipment..

F. Related Sections
   1. To be developed

1.3 REFERENCE STANDARDS

A. Compliance with Local Requirements: Comply with applicable building code, local ordinances and regulations, and requirements of authorities having jurisdiction.

B. The BTSs for the cellular system shall be provided by mobile operators and should follow the below standards:
   1. 2G standards governed by European Telecommunications Standards Institute (ETSI).

2. 4G LTE standards
3. 3GPP
4. ITU-T Telecommunication Standardization Sector of the International Telecommunications Union

C. All materials, installation and workmanship shall comply with the following organization guidance and/ or standards:
1. TRA Regulatory Policy: Private Mobile Radio Service - Version 1.0, Issue Date: 30 December 2009
2. EN 300 296: Land Mobile Service; Radio equipment using integral antennas intended primarily for analog speech;
3. EN 300 471-2: Land Mobile Service
4. EN 50174-1 + A2: Information Technology – Cabling Installation, Part 1 Installation specification and quality assurance and all introduced contextual relationships with relevant standards in the EN50173 and EN50174 series.
5. EN50383, EN50384, EN50385: Specific Absorption Rate
6. ETSI EG-200-053: EMC compatibility, and radio site/system engineering
7. ETS 300 019: Environmental Engineering (EE)
8. ICNIRP Guidelines: Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields.
9. IEC 61196-4: Coaxial communication cables - Part 4: Sectional specification for radiating cables – performance and test methods
10. ETSI TR 102: Designer's Guide
11. NFPA-1221 : Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems

D. Comply with the latest issue of:
1. NFPA 72, "National Fire Alarm Code".

E. Local regulations and standards, where enforced and relevant, are to have precedence over the Standards.

1.4 DEFINITIONS AND ABBREVIATIONS

A. To be developed

1.5 SCOPE OF WORK

A. Refer to Division W, Section "Common Clauses for IT & Security Systems" for requirements.

B. System design & Implementation must be done by certified company.

C. To be developed

1.6 CONFIDENTIALITY

A. The Contractor shall respect and protect the privacy and confidentiality of the Employer, his employees, processes, products, and intellectual property to the extent necessary, consistent with the legal responsibilities of the Employer policies.

B. Contractor shall sign a non-disclosure agreement and abide by the requirements to keep confidential all information concerning bid documents and this Project.

1.7 SYSTEM DESCRIPTION AND PERFORMANCE

A. All specified components shall meet at minimum the performance specifications of this article.

B. The Contractor shall submit shop drawings showing system layout and link budget calculations based on the equipment selected to meet performance criteria in this specification.

C. Radio signals shall be combined, amplified and transported from the head-end location to in-building distributed antenna locations using a combination of active equipment, fiber optic cable and coaxial cable.

D. Distributed antennas shall be located to minimize interference and intermodulation other antennas and other wireless systems. The design shall include minimum separation between various antenna types.

E. To be developed

1.8 SUBMITTALS

A. The Contractor shall not perform any part of the work requiring submittal and review of shop drawings, product data or samples until Engineer / Employer has approved the respective submittal.

B. Samples for initial selection:

C. Operating License for the System as required by local regulations and Authorities Having Jurisdiction:

D. Product Certificates:

E. Manufacturer’s Endorsement

F. Signed Warranty: as specified.

G. Testing Plan:

H. Test Equipment

I. Product data: For each type of product.

J. Shop Drawings

K. Qualifications

L. Closeout Submittals (Record Documents):

M. Operations and Maintenance Manuals

1.9 QUALITY ASSURANCE

1. To be provided

1.10 DELIVERY, STORAGE, AND HANDLING

A. Comply with Division, Section “Product Requirements”.

1.11 PROJECT/SITE CONDITIONS

A. Environmental Conditions: to be developed

B. Operational Constraints: The system will run 24 hours per day, all the days of the year.

C. Power Supply

1.12 COORDINATION

A. To be provided

1.13 LICENSING REQUIREMENTS

A. To be provided

1.14 WARRANTY AND MAINTENANCE

A. Refer to Division W, Section “Common Clauses for IT & Security Systems” for requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements. Manufacturers shall meet all specifications requirements and shall be approved by the Engineer.

2.2 SYSTEM REQUIREMENTS

A. To be provided

2.3 SYSTEM COMPONENTS

A. Active Equipment :
1. Optical Remote Unit (ORU)
2. Optical Master Unit (OMU)

B. PASSIVE EQUIPMENT: Capable of operating in the 66-2700 MHz frequency range, and shall include:
1. Antennas
2. Splitters
3. Couplers
4. Low Loss (Coaxial RF) Cable
5. Radiating Cables (RF Leaky Cable)
6. Terminators/Dummy Loads

7. Connectors
8. Fiber Optic Cables
9. Fiber Optic Patch Panels
10. Cable Containment System

2.4 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Refer to Division 27 Section “Common Clauses for IT, Security & Special Airport Systems”.

2.5 SIGNAL TRANSMISSION COMPONENTS

A. Refer to Division 27 Section “Common Clauses for IT, Security & Special Airport Systems”.

2.6 CONDUITS, TRUNKING, ENCLOSURES AND FITTINGS

A. Refer to Division 27 Section “Common Clauses for IT, Security & Special Airport Systems”.

PART 3 - EXECUTION

3.1 INSTALLATIONS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems” for requirements.

3.2 FIRE-STOPPING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems” for requirements.

B. to be developed

3.3 GROUNDING

A. To be developed

3.4 FIELD QUALITY CONTROL

A. To be developed

3.5 OCCUPANCY ADJUSTMENTS

A. To be developed

3.6 DEMONSTRATION AND TRAINING

A. Train Employer's maintenance personnel to adjust, operate, and maintain the system installation.

W24 - GENERAL CONDITIONS FOR INTEGRATED AUDIOVISUAL SYSTEMS

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. Section includes general design requirements, administration topics and installation for audiovisual systems.

100.020 PERFORMANCE STANDARDS

A. Unless required by the specifications of a particular equipment or system, the following performance standards shall be met by each system:

1. Analog Audio

a) Frequency Response

1) Within plus or minus 0.5dB, 20 Hz to 20,000 Hz.

b) Signal to Noise Ratio

1) greater than 90dB (including crosstalk and hum at all input/output levels)

c) Total Harmonic Distortion

1) 0.05% maximum from 20 Hz to 20,000 Hz.

d) Input Levels

1) Microphone (Nominal): -50dBu
2) Overload (Minimum gain) : -5dBu
3) Maximum Gain: -26dBu
4) Line (Nominal): +4dBu
5) Overload (Minimum gain):+24dBu
6) Maximum Gain: +9dBu
7) Input Common Mode Rejection: >100dB

e) Output Levels

1) Line (Nominal): +4dBu
2) Maximum: +24dBu
3) Output Impedance: <15 Ohms

B. Performance Test Signal Paths

1. The signal paths for the above Performance Standards shall be as follows:

a) Audio:

1) From all source inputs (for microphones, audio units, video units, etc.) through all mixers, switchers, etc., to all signal destinations.

b) Video:

1) From all sources of the above signal paths. This shall not exempt the Contractor from the responsibility of checking all paths and outlets for appropriate compliance with the Performance Standards listed herein.

C. Optical Performance Standards

1. System design shall be based "ANSI/Infocomm 3M: 2011, Projected Image System Contrast Ratio", with the following performance criteria:

a) Viewing Requirement Categories Rationale: Basic Decision Making.
b) Contrast ratio between the ambient light and the projected image (assuming perfect black level for the projector): 15:1.

c) Minimum overlapping (for projection mapping): 10%.
d) Uniformity: Shall conform to "ANSI/Infocomm 3M: 2011, Projected Image System Contrast Ratio" standard "Partially Conforms" verification criteria; "The contrast ratio of one but no more than four measurement (viewing) locations falls below the required contrast ratio for the identified viewing category by no more than 10%."

D. Control System User Interface

1. Control system user interfaces pages shall be designed for this project exclusively. While there are a great number of design approaches to designing the user interface, the following guidelines shall be adhered to:

a) All panels shall have the time and date as icons, in the same position on every page.
b) All panels shall have a title, indicating the piece of equipment and/or functionality being controlled.
c) User interface design, shall, to the greatest extent possible maintain continuity throughout the Project, taking into account the variations in system functionality from room type to room type.
d) Comply with the recommendations of "InfoComm, Dashboard for Controls Design Guide" or similar approved design guide.

2. Final programming shall include capability to remotely control all functions of the Audiovisual system. Individual device controls shall provide full manufacturer's functionality.
3. Devices similar in nature shall be programmed to operate with a common format.
4. Functions used during a general presentation shall be accessible with a minimal amount of button presses/page flips.
5. Where feasible, multi-level access to controls should be implemented.
6. During performance testing, all equipment shall be operated under standard conditions as recommended by the manufacturer.

E. Acoustics

1. System design shall be based on the following performance criteria (for meeting rooms and conference rooms):

a) Average sound pressure level: 75 to 80 dB
b) Amplifiers shall have a dynamic headroom of +40% over the required power.
c) Intelligibility index: STI: better than 0.60
d) Sound diffusion level: 15 dB (A) above ambient noise level.
e) Total harmonic distortion: maximum 0.05% at specified output level.
f) Frequency response: +/- 3 dB over 100 Hz to 20 kHz.
g) Performance coverage envelope: 3 dB (0.25, 0.5, 1, 2, 4 and 8 kHz).

F. A/V Equipment - General

1. A/V equipment shall be compliant with the transport of combined digital audio and video signals in the High-Definition Multimedia Interface (HDMI) or DisplayPort format. HDMI components shall support HDMI 2.0b or latest version providing a minimum of 18 Gbps data rate supporting 4K video signals (3840x2160 at up to 60 fps), 3D, and high-definition audio formats.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. The publications listed below form a part of this specification. The publications are referred to in the text by basic designation only.

C. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean reference to the latest printed edition of each.

D. Conflicts

1. Should an instance occur in this Specification or on the Drawings in which material or construction methods called for is less than minimum requirement of the reference standards, immediately inform the Engineer in writing. Consequent to Engineer's approval, supply the materials and perform the work as though called for to minimum code standards.

E. Referenced Standards

1. International British (BS), European (EN) and IEC Standards which are in relationship with each other, tackle the same topic and carry the same number, can be used interchangeably in this specification since they are assumed to have the same intent and target the same level of quality and safety. For example: BS EN 60529 and IEC 60529. This shall be applicable to all subjects except for life safety related materials and systems (such as the Fire Alarm System) whereby BS / BS EN shall remain mandatory.

F. All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references.

1. UL: Underwriters Laboratories.
2. EIA: Electronic Industries Alliance.
3. ECIA: Electronic Components Industry Association.
4. TIA: Telecommunications Industry Association.
5. ISO: International Standards Organization.
6. IEC 60268-16, Sound system equipment - Part 16: Objective rating of speech intelligibility by speech transmission index.
7. AVIXA (Formerly INFOCOMM International).
    a) ANSI/INFOCOMM A102.01:2017, Audio Coverage Uniformity Standard in Listener Areas.
    b) ANSI/INFOCOMM 2M – 2010, Standard Guide for Audiovisual Systems Design and Coordination.
    c) ANSI/INFOCOMM 3M – 2011, Projected Image System Contrast Ratio.
    d) AVIXA F501.01:2015 (Formerly INFOCOMM F501.01:2015), Cable Labeling for Audiovisual Systems.
    e) AVIXA V202.01:2016 (Formerly ANSI/INFOCOMM V202.01:2016), Display Image Size for 2D Content in Audiovisual Systems.
    f) ANSI/INFOCOMM 10:2013, Audiovisual Systems Performance Verification
    g) InfoComm, Dashboard for Controls Design Guide
8. ANSI X3T12: for FDDI and CDDI.
9. IEEE 802.3 – Carrier Sense Multiple Access/Collision Detection Access Methods (Ethernet).
10. Society of Motion Picture and Television Engineers (SMPTE).
11. Electrical equipment, devices and components shall comply with the appropriate Class for project environment as per requirements of EMC:
    a) EN 61000-6-1, Electromagnetic compatibility (EMC). Generic standards. Immunity for residential, commercial and light-industrial environments.
    b) EN 61000-6-3, Electromagnetic compatibility (EMC). Generic standards. Emission for residential, commercial and light-industrial environments.
    c) EN 61000-6-2, Electromagnetic compatibility (EMC). Generic standards. Immunity for industrial environments.
    d) EN 61000-6-4, Electromagnetic compatibility (EMC). Generic standards. Emission for industrial environments.
12. European Directives:
    a) European Low Voltage Directive (LVD) 2014/35/EU.
    b) European Radio Equipment Directive (RED) 2014/53/EC.
    c) Directive on Waste Electrical and Electronic Equipment (WEEE) 2012/19/EU.
13. Power Quality

a) EN 61000-3-2: Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current ≤ 16 A per phase).
b) EN 61000-3-3: Electromagnetic compatibility (EMC) - part 3-3: limits - limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection.

14. Information Technology equipment, devices and components shall comply with the appropriate Class for project environment as per requirements of EMC:

    a) EN 55035, Electromagnetic compatibility of multimedia equipment. Immunity requirements
    b) EN 55032, Electromagnetic compatibility of multimedia equipment. Emission Requirements.

15. For interface with the Fire Alarm System, comply with the latest issue of:

    a) NFPA recommendations

16. All electrical works shall comply with applicable local regulations and code requirements of Authorities Having Jurisdiction. Refer also to Division V Section "Basic Electrical Materials and Methods".

G. All A/V systems designed and installed shall meet the most current version of the Accessibility Guidelines by Authorities Having Jurisdiction, including assisted listening systems, visual access and accommodations.

H. All A/V equipment (such as display units) shall be "ENERGY STAR qualified" products or equivalent international certification program wherever possible. They shall carry the latest applicable version of ENERGY STAR label or equivalent.

I. Local regulations and codes. These are to have precedence over the Standards where enforced and relevant.

110.020 PROJECT/SITE CONDITIONS

A. Environmental Conditions: Equipment shall be capable of withstanding the project environmental conditions specified under Division V Section "Basic Electrical Materials and Methods" encountered at the installed location without mechanical or electrical damage or degradation of operating capability as applicable to:

1. Interior, Controlled Environments.

B. To be developed

110.030 DEFINITIONS AND ABBREVIATIONS

A. Definitions

1. Gain is a measure of a screen's reflectivity – i.e. how much light the screen reflects, and ultimately how well the screen redirects light from the projected image to the audience. It is measured from the viewing angle where the screen reflects the most light, which is directly in front and at a 90 degree angle to the screen. Gain is measured relative to a block of magnesium carbonate which is a very white chemical coating that serves as the standard for 1.0 gain. A number higher than 1.0 indicates greater brightness. Gain shall be determined in accordance with SMPTE RP 94-2000.
2. Viewing angle: Angle from perpendicular of screen center at which the brightness of the image is half of its maximum potential.
3. Keystone: Distortion of projected image when the projector is not aligned perpendicularly to the projection screen.
4. Reference to "U.L. (Materials Construction) Standards" shall mean the "Standards for Safety" published by Underwriters Laboratories, Inc.
5. SYSTEM: The Audio-Visual System to which these Specifications apply.
6. Scaler: A device that converts video signals from one resolution or frame rate to another; usually up-scaling or up-converting a video signal from a low resolution to one of higher resolution.

7. Line driver: A signal amplifier used to extend an audio or video signal over extended distances. Similar in function to a distribution amplifier, but with one input and one output
8. Extender: similar to the line driver but operates in transmitter and receiver pairs to allow long distance transmission of digital signals via twisted pair or fiber optic cable
9. Matrix Switcher: Routes multiple audio/video sources to multiple audio/video destinations. It receives A/V signals from a range of input sources - computers, cameras, Disc players, etc. - and routes the output to different destinations, such as projectors and flat panel displays.
10. Phantom Power: Phantom power is a means of distributing a DC current through audio cables to operate microphones and other equipment that contain active electronic circuitry. The supplied voltage is usually between 12 and 48 Volts, with 48V being the most common.

B. Abbreviations

1. Alcons: Articulation loss of consonant
2. A/V: Audiovisual
3. CDDI: Copper Distributed Data Interface.
4. EDID: Extended display identification data
5. FDDI: Fiber Distributed Data Interface.
6. HDCP: High-bandwidth Digital Content Protection
7. HDMI: High-Definition Multimedia Interface
8. HID Human Interface Device
9. IWB: Interactive WhiteBoard
10. KVM Keyboard, Video and Mouse
11. SMTP: Simple Mail Transport Protocol.
12. SNPP: Simple Network Paging Protocol
13. STB: Set-Top Box (IPTV)
14. STI: Speech Transmission Index
15. TFT: Thin-Film-Transistor
16. TMDS: Transition-Minimized Differential Signalling
17. VCSS: Video Communications Server

120.000 SYSTEM DESCRIPTION

120.010 SCOPE OF WORK

A. General: Provide audiovisual systems design, engineering, and installation within designated spaces of the Project **.** Systems shall include all devices, equipment, installation, programming and commissioning in accordance with requirements of the contract documents and drawings.

B. Works Included:

1. Refer to the following Sections for scope of work and system description for each Room Type:

a) Section W24A - Integrated Audiovisual Systems and Equipment – For Meeting Rooms.
b) Section W25 – Digital Media Displays.

C. To be developed.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. General

1. Drawings and general provisions of the Contract, including Project "Preliminaries and General Requirements", apply to this Section.
2. All the requirements presented in this Specification "General Conditions for Integrated Audiovisual Systems" shall be complimentary to and shall apply to the following A/V Systems except where a particular A/V System Specification document calls for otherwise. In this case, the individual A/V System Specification shall have precedence:

a) Section W24A - Integrated Audiovisual Systems and Equipment – For Meeting Rooms.

b) Section W25 – Digital Media Displays.

B. Related Sections:

1. To be developed

PART 3 PRODUCTS AND WORKMANSHIP

300.000 PRODUCTS

300.010 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but not limited to:

B. Audio Systems

1. To be developed

C. Displays

1. To be developed

D. Presentation Source Equipment

1. To be developed

E. Control Systems

1. To be developed

F. Equipment Racks/Cabinets

1. To be developed

G. Cables

1. To be developed

H. TV Broadcasting Network Products

1. To be developed

300.020 MATERIALS - GENERAL

A. Refer to the following Specification Sections for Equipment Specifications and schedules by individual Room type:

1. Section W24A, “Integrated Audiovisual Systems and Equipment – For Meeting Rooms”.

B. Refer to the following Specification Section for Equipment Specifications and schedules by System type:

1. Section W25, “Digital Media Displays”.

300.030 TECHNICAL PANELS, BOXES AND COVER PLATES

A. General

1. Refer to:

a) Division V Section “Wiring Devices” for device boxes, cover plates and floor-box service fittings.
b) Division Y Section “Raceways and Boxes for Electrical Systems” for boxes.

B. Configuration:

1. To be developed
2. Submit manufacturer’s detailed assembly drawing indicating configuration and details related to material, finish and tagging.

300.040 EQUIPMENT RACKS/CABINETS

A. Equipment Rack/Cabinet

1. Comply with Division W, Section “Communications Equipment Room Fittings ” for equipment racks and cabinets.

B. Configuration

1. To be developed
2. Comply with EIA/ECA-310-E.

C. Power Management

1. To be developed

D. Rack/Cabinet Accessories:

1. To be developed
2. Contractor to determine ventilation requirements to maintain 30 Deg. C maximum temperatures. Provide:

a) One or two quiet fans in top knockouts of each rack, as required.
b) Vent blockers to facilitate proper air movement.
c) Thermostatic fan control
d) Other measures as proposed by Contractor for guaranteed proper thermal management.

300.050 A/V CREDENZA

A. General

1. Comply with Division W, Section “Communications Equipment Room Fittings” for equipment racks and cabinets.

B. Configuration

1. Modular, consisting of multiple bays.
2. To be developed

C. Power Management

1. To be developed

D. Rack/Cabinet Accessories:

1. To be developed
2. Wire Duct: wide slot wiring duct, size as required.
3. Contractor to determine ventilation requirements to maintain 30 Deg. C maximum temperatures. Provide:

a) Quiet fans in top knockouts of each rack, as required.
b) The overall fan noise at full load capacity shall not exceed 35dBA measured at 1m from the credenza.
c) Vent blockers to facilitate proper air movement.
d) Thermostatic fan control
e) Other measures as proposed by Contractor for guaranteed thermal and acoustical management.

300.060 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. To be developed

B. Remote field-mounted components shall be fed from the nearest UPS source.

C. Coordinate UPS voltage, circuit size, and connection requirements with the Project Electrical design.

D. Coordinate UPS configuration - whether centralized or decentralized, redundant or non-redundant with the Project Electrical design.

E. Ensure that the allocated space and environmental conditions are adequate for the adopted configuration.

F. Comply with Division V, Section “Uninterruptible Power Supply”.

300.070 WIRE AND CABLE

A. General Cable Requirements: Size and type as recommended in writing by system manufacturer unless otherwise indicated.

B. Comply with the following Specification Sections – as applicable to power, control, data and video signal transmission cables:

1. To be developed

C. Low Smoke Zero Halogen (LSZH/LS0H) cables: for plenum installation as per adopted Standards for the Project.

1. Low Smoke Zero Halogen (LSZH/LS0H) cables shall comply with the following European Standards:

a) Flame retardant: IEC 60332-1.
b) Halogen-free according to:

1) IEC 60754-1 for amount of halogen acid gas.
2) IEC 60754-2 for corrosiveness of combustion gases according to (degree of acidity).

c) Low smoke density according to IEC 61034-2.

D. Fire Resistant Cables: For life safety installations interface. Refer to Division Y Section "Low-Voltage Electrical Power Conductors and Cables".

1. Use Fire-resistant cables Type FR4

E. Grounding Components: To be developed.

F. Cable Types

1. To be developed

G. Connectors

1. To be developed

300.080 MEDIA BROADCASTING NETWORK PRODUCTS

A. Description

1. Media Broadcasting cables and their connecting hardware shall provide the means of transporting signals between the media broadcast outlet/connector and the horizontal cross-connect .

B. To be developed

300.090 CONDUITS, TRUNKING, ENCLOSURES AND FI TTINGS

A. Where rack, cabinet, or console mounting is indicated, equipment shall be designed to mount in a 19-inch (483-mm) housing complying with EIA/ECA-310-E and Division W, Section “Communications Equipment Room Fittings**”.**

B. To be developed

300.100 SPECIAL TOOLS AND KITS

A. The Contractor shall furnish any special installation equipment, tools, or kits necessary to properly complete the telecommunications system installation. This may include, but is not limited to, tools for pulling, splicing, terminating, and testing the cables, communication devices, stands for cable reels, cable wenches, assembly and adjustment devices, etc.

B. To be developed

310.000 QUALITY MANAGEMENT

310.010 PRODUCTS AND WORK BY OTHERS / COORDINATION

A. To be developed

310.020 CONFIDENTIALITY

A. The Contractor shall respect and protect the privacy and confidentiality of Employer, his employees, processes, products, and intellectual property to the extent necessary, consistent with the legal responsibilities of the Employer policies.

B. Contractor shall sign a non-disclosure agreement and abide by the requirements to keep confidential all information concerning bid documents and this Project.

310.030 QUALITY ASSURANCE

A. Project Management

1. To be developed

B. Contractor's Qualifications

1. To be developed

C. Materials and Equipment

1. To be developed

D. Administrative Requirements

1. To be developed

310.040 DELIVERY, STORAGE AND HANDLING

A. Comply with Project "Preliminaries and General Requirements".

310.050 WARRANTY AND MAINTENANCE

A. Contractor shall provide a two years warranty for the works, Systems, and subsystems specified herein, including all materials, software and labor, to be free from defects in design, workmanship, and materials.

B. System Availability

1. At any given time, the overall A/V shall be considered unavailable if the system is not available, not fully or accurately functional, or does not meet performance criteria for the given connection.
2. All A/V components shall execute, without degradation, at the scheduled periods and response times for the systems to be considered available.
3. The systems shall operate as specified under Article "PROJECT/SITE CONDITIONS", Paragraph "Operational Constraints".
4. Availability of the overall A/V shall be at least 99.999% within the specified "Operational Constraints".

C. Warranty period shall commence from date of Taking Over of the SYSTEM

D. Experimental Period

1. After the on-site tests are satisfactorily completed in accordance with the technical specifications and approved procedures, and before Taking Over, assume a one-month experimental period during which the SYSTEM performance will be fully demonstrated under actual operation conditions. This demonstration is to confirm, to the satisfaction of the Employer / Engineer that the SYSTEM is free of remarks and is ready for taking-over.
2. Contractor shall supervise and take responsibility for the operation of the system during the experimental period. After the satisfactory completion of this period, the system shall be taken over by the Employer, as per Contract conditions, whereby the warranty period shall commence.

E. Software Service

1. Technical Support: Provide software support for two years, beginning at Project Completion.
2. To be developed

310.060 SPARE PARTS AND EXTRA MATERIAL

A. The manufacturer shall guarantee the flow and availability of the spare parts without a major design change for at least ten years' period from date of System Acceptance by Employer.

B. To be developed

320.000 SUBMITTALS

A. The Contractor shall not perform any part of the work requiring submittal and review of shop drawings, product data or samples until Engineer and/or Employer has approved the respective submittal. Such work shall be in accordance with approved submittals:

1. Product data: For each type of product.
2. Shop Drawings.
3. Wiring diagrams to show typical wiring schematics.
4. System Operation: Include:

a) System Architecture and performance requirements.
b) Inter-connectivity patching of all network devices
c) Human Machine Interface (HMI) design for all categories of users.
d) Software Architecture and justification (e.g.: off-the-shelf and specific software, etc.).

B. Submittals shall comply with Project "Preliminaries and General Requirements".

C. Samples for initial selection:

1. To be developed

D. Prefabrication Submittals

1. To be developed

E. Product Certificates: signed by manufacturers of equipment and /or software certifying that furnished products comply with contract requirements.

F. Manufacturer's Endorsement

1. Contractor shall submit Manufacturer's technical validation and endorsement of the design documentation and implementation.

G. Calculations

1. To be developed

H. Coordination Drawings:

1. To be developed

I. Shop Drawings shall include the following:

1. To be developed

J. Qualifications

1. The Contractor shall provide the appropriate documentation to comply with the requirements described in Article "QUALITY ASSURANCE", included with, and at the time of, bid submission.

K. Closeout Submittals (Record Documents):

1. To be developed

L. Operations and Maintenance Manuals

1. To be developed

M. To be developed

330.000 EXECUTION

330.010 INSTALLATION

A. To be developed

B. Workmanship: To be developed

C. Cables: To be developed

D. Equipment Modification: To be developed

E. Firestopping: To be developed

F. Grounding and Bonding: To be developed

G. Equipment: To be developed

H. Motorized Projector Lifts: To be developed

I. Mounting Heights: To be developed

J. Cable Separation: To be developed

330.020 FACTORY ACCEPTANCE TESTS

A. The Factory Acceptance Tests shall be carried out in a hardware and software environment, which simulates the final configuration of the SYSTEM.

B. To be developed

330.030 FIELD QUALITY CONTROL

A. Contractor System Checkout

1. To be developed

B. System Acceptance Tests

1. To be developed

C. Experimental Period: To be developed

330.040 DEMONSTRATION AND TRAINING

A. To be developed

W24A - INTEGRATED AUDIOVISUAL SYSTEMS AND EQUIPMENT - FOR MEETING ROOMS

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. The audiovisual systems within the Meeting Room shall provide the audiovisual capabilities required for effective instruction and learning, including the following:

1. Audio program presentation
2. Speech audio reinforcement
3. Audio-conference communication
4. Video program presentation
5. Wireless presentation

100.020 PERFORMANCE STANDARDS

A. Refer to Division W, Section “General Conditions for Integrated Audiovisual Systems”.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Refer to Division W, Section “General Conditions for Integrated Audiovisual Systems”.

110.020 PROJECT/SITE CONDITIONS

A. Refer to Division W, Section “General Conditions for Integrated Audiovisual Systems”.

110.030 DEFINITIONS AND ABBREVIATIONS

A. Refer to Division W, Section “General Conditions for Integrated Audiovisual Systems”.

120.000 SYSTEM DESCRIPTION

120.010 SCOPE OF WORK

A. Refer to Division W, Section “General Conditions for Integrated Audiovisual Systems”.

120.020 SYSTEM DESCRIPTION

A. The A/V system shall consist of the following sub-systems:

1. Audio program reinforcement system
2. Speech and Audio-conference reinforcement system
3. Video presentation display system. Front projection
4. Video presentation display system. Flat panel display
5. Wireless presentation system
6. Control system with a touch-screen control panel to allow system operator to control the following functions:

B. All systems shall be dedicated and permanently installed.

C. The systems shall utilize the building local area network for audio and video input and output, system control and maintenance and monitoring functions.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. General

1. Refer to Division W Section W24 “General Conditions for Integrated Audiovisual Systems”.

B. Related Sections:

1. To be developed

210.000 RELATED PRODUCTS

210.010 MISCELLANEOUS PRODUCTS AND SYSTEMS

A. For the following miscellaneous products and systems, refer to Division W, Section “General Conditions for Integrated Audiovisual Systems”:

1. TECHNICAL PANELS, BOXES AND COVER PLATES
2. EQUIPMENT RACKS/CABINETS
3. A/V CREDENZA
4. UNINTERRUPTIBLE POWER SUPPLY (UPS)
5. WIRE AND CABLE
6. CONDUITS, TRUNKING, ENCLOSURES AND FITTINGS
7. SPECIAL TOOLS AND KITS

PART 3 PRODUCTS AND WORKMANSHIP

300.000 PRODUCTS

300.010 MANUFACTURERS

A. Refer to Division W, Section “General Conditions for Integrated Audiovisual Systems”.

300.020 AUDIO SYSTEMS

A. Audio Digital Signal Processors: Networked

1. To be developed

B. Power Amplifiers: Networked

1. To be developed

C. Loudspeakers

1. Ceiling speaker
    a) To be developed
2. Program speaker, wall mounted
    a) To be developed

D. Microphones and Accessories

1. Lectern/Table Mounted Gooseneck Cardioid Microphone
    a) To be developed
2. In-Table "button type" Microphone
    a) To be developed
3. Ceiling-mounted Networked Microphone Array

a) To be developed

4. Table-mounted Networked Microphone Array
    a) To be developed

300.030 DISPLAYS

A. Flat Panel Displays
    1. To be developed
B. Display Mount
    1. To be developed
C. Video Projectors - Small Venue
    1. To be developed
D. Front Projection Screens
    1. To be developed

300.040 PRESENTATION SOURCE EQUIPMENT

A. Analog Audio Signal Interfaces/Line-Drivers
    1. To be developed
B. Blu-Ray Disk Player
    1. To be developed
C. Digital Extender Transmitter / Receiver
    1. To be developed
D. Digital Audio-Video Matrix Switcher
    1. To be developed
E. HDMI Audio De-Embedder
    1. To be developed
F. Wireless Presentation System
    1. To be developed
G. A/V Connection Plate (Media Hub) (Input Plate)
    1. To be developed
H. IPTV Set-Top Box
    1. To be developed

300.050 CONTROL SYSTEMS

A. System Controller – Large
    1. To be developed
B. System Controller - Small
    1. To be developed
C. Wired Wall Mount Touch Panel
    1. To be developed
D. Wireless Touch Panel
    1. To be developed

E. Keypad Controller

1. To be developed

F. Room Scheduling Panel

1. To be developed

G. Room Scheduling, Management and Asset Management System

1. To be developed

310.000 QUALITY MANAGEMENT

310.010 MISCELLANEOUS QUALITY MANAGEMENT TOPICS

A. For the following quality management topics, refer to Division W, Section "General Conditions for Integrated Audiovisual Systems":

1. PRODUCTS AND WORK BY OTHERS / COORDINATION
2. CONFIDENTIALITY
3. QUALITY ASSURANCE
4. DELIVERY, STORAGE AND HANDLING
5. WARRANTY AND MAINTENANCE

310.020 SPARE PARTS AND EXTRA MATERIAL

A. Refer to Division W, Section "General Conditions for Integrated Audiovisual Systems".

B. To be developed

320.000 SUBMITTALS

A. Provide in accordance with Division W, Section "General Conditions for Integrated Audiovisual Systems".

330.000 EXECUTION

330.010 MISCELLANEOUS FIELD AND INSTALLATION WORK TOPICS

A. For the following topics, refer to Division W, Section "General Conditions for Integrated Audiovisual Systems":

1. INSTALLATION
2. FACTORY ACCEPTANCE TESTS
3. FIELD QUALITY CONTROL
4. DEMONSTRATION AND TRAINING

W25 - DIGITAL MEDIA DISPLAYS

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. Section includes Digital Media Displays used to provide advertisements, TV content and branding information throughout the Project public areas.

1. The technology shall be the latest technology, for example: TFT-LCD Displays with edge LED back light, and Full Matrix LED.
2. The information to be displayed on the Digital Media Displays shall be generated, hosted and distributed by various Systems including but not limited to IP–Based Television System (IPTV)
3. Data shall be transported along the Project Data Network which generates graphical output to the Screen.

100.020 PERFORMANCE STANDARDS

A. Refer to Division W, Section “General Conditions for Integrated Audiovisual Systems”.

B. General Requirements for Displays

1. The Contractor shall use well-proven and market available product and technologies (e.g. propose display panels with LED backlight or better).
2. The proposed displays shall be slim and light weight, suitable for public displays.
3. The proposed display shall be already available on other projects of comparable size.
4. The display panels shall be capable of working continuously 24/7 under public commercial environment conditions without any degradation or limitation of their performance and without developing any visually apparent effects deemed undesirable by the Employer.
5. The life span of the equipment and their associated peripherals shall be at least 5 years, based on a continuous 24-hours operational schedule.
6. All displays shall perform 24/7 operations without preventive maintenance
7. All displays shall be capable of displaying information in both landscape and portrait orientation.
8. The Contractor shall provide the enclosures of the display and shall ensure that all connectors and controllers are accessible while the display is mounted.
9. The Contractor shall ensure that the provided structure and screen enclosures will have sufficient ventilation to meet the displays’ operating temperature.
10. The displays shall have relevant self-diagnostic functions to support trouble-shooting and preventive maintenance. These relevant self-tests shall be initiated each time the equipment is powered up.
11. The display shall comply with the latest industry standards for high operational reliability and availability.
12. The Contractor shall provide the necessary display frame size, color and finishes to meet the architectural requirements at the installation area.
13. Displays shall be provided with mounting brackets with adjustable 0-15 degree tilt angle.
14. Mounting brackets shall be coordinated with the Architectural design.
15. The Contractor shall be fully responsible for the mechanical interface of the proposed bracket with the supporting structure (wall, column, etc.) and in coordination with the Building Contractor in charge of the supporting structure.
16. There shall be no panel or switch accessible from the front or the side of the frame of the display. Manipulation by unauthorized people shall be made as difficult as possible. All manual controls on the outer side of the display, allowing access to the display system, shall be deactivated by software, if required, for security reasons.
17. The display shall have a built-in power supply compatible with Project mains power supply characteristics.
18. A 3m power cord with plug shall be provided for the display panel and associated controller. The plug shall conform to the Project socket outlets standard.

19. The display panel and associated controller shall have adequate built-in protection against over-voltage and over-current.
20. LCD Displays shall have full motion video display capability with support for multiple formats, so that if not actively used for signage functions, they can be used for public awareness information by commercial video advertising bodies.
21. To be developed.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Refer to Division W, Section “General Conditions for Integrated Audiovisual Systems”.

110.020 PROJECT/SITE CONDITIONS

A. Refer to Division W, Section “General Conditions for Integrated Audiovisual Systems”.

110.030 DEFINITIONS AND ABBREVIATIONS

A. Refer to Division W, Section “General Conditions for Integrated Audiovisual Systems”.

B. Definitions

1. Digital Media Display shows dynamic digital content such as pictures slide shows, video clips, animations, video streaming, television
2. LCD: Liquid Crystal Display.
3. TFT-LCD: Thin-Film Transistor Liquid Crystal Display
4. LED: Light Emitting Diode display with dot matrix mode of LED’s
5. Digital media Controller: Windows or Linux based media player which can connect to the network and any video source provided.

120.000 SYSTEM DESCRIPTION

120.010 SCOPE OF WORK

A. Refer to Division W, Section “General Conditions for Integrated Audiovisual Systems”.

120.020 SYSTEM DESCRIPTION

A. The A/V system shall consist of video presentation 16:9 HD display systems consisting of:

1. Flat Panel Displays – configured into arrays
2. Video Walls and associated video wall controllers

B. The video presentation signals shall be sourced from:

1. A local or portable computer and/or laptop.
2. Blu-Ray disk player or other video sources.

C. All systems shall be dedicated and permanently installed.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. General

1. Refer to Division W Section W24 “General Conditions for Integrated Audiovisual Systems”.

B. Related Sections:

1. To be developed

210.000 RELATED PRODUCTS

210.010 MISCELLANEOUS PRODUCTS AND SYSTEMS

A. For the following miscellaneous products and systems, refer to Division W, Section "General Conditions for Integrated Audiovisual Systems":

1. TECHNICAL PANELS, BOXES AND COVER PLATES
2. UNINTERRUPTIBLE POWER SUPPLY (UPS)
3. WIRE AND CABLE
4. CONDUITS, TRUNKING, ENCLOSURES AND FITTINGS
5. SPECIAL TOOLS AND KITS

PART 3 PRODUCTS AND WORKMANSHIP

300.000 PRODUCTS

300.010 MANUFACTURERS

A. Refer to Division W Section "General Conditions for Integrated Audiovisual Systems".

300.020 VIDEO WALL DISPLAYS

300.030 VIDEO WALL REAR-PROJECTION DISPLAY MODULES (CUBES)

1. To be developed

300.040 MODULAR TILE (MICROTILE) DISPLAYS AND CONTROLLER

1. Commercial commercial-grade MicroTile displays with DLP technology, consisting of display units, screens and external control units (ECU's).
2. To be developed

300.050 VIDEO WALL LCD FLAT PANEL DISPLAYS

1. Commercial-grade LCD display with LED backlight designed specifically for 24/7 operation.
2. To be developed

300.060 VIDEO WALL CONTROLLERS

300.070 VIDEO WALL CONTROLLER – NETWORK-BASED STREAMING SYSTEM

1. Video Wall Processor Node
2. Video Wall Encoder
3. Video Wall Recording

300.080 INTERACTIVE INFORMATION KIOSK

300.090 DIGITAL WAYFINDING AND VISUAL PAGING

310.000 QUALITY MANAGEMENT

310.010 MISCELLANEOUS QUALITY MANAGEMENT TOPICS

A. For the following quality management topics, refer to Division W, Section "General Conditions for Integrated Audiovisual Systems":

1. PRODUCTS AND WORK BY OTHERS / COORDINATION
2. CONFIDENTIALITY
3. QUALITY ASSURANCE
4. DELIVERY, STORAGE AND HANDLING
5. WARRANTY AND MAINTENANCE

310.020 SPARE PARTS AND EXTRA MATERIAL

A. Refer to Division W, Section “General Conditions for Integrated Audiovisual Systems”.

B. To be developed

320.000 SUBMITTALS

A. Provide in accordance with Division W, Section “General Conditions for Integrated Audiovisual Systems”.

330.000 EXECUTION

330.010 MISCELLANEOUS FIELD AND INSTALLATION WORK TOPICS

A. For the following topics, refer to Division W, Section “General Conditions for Integrated Audiovisual Systems”:

1. INSTALLATION
2. FACTORY ACCEPTANCE TESTS
3. FIELD QUALITY CONTROL
4. DEMONSTRATION AND TRAINING

W31 - COMMON CLAUSES FOR IT & SECURITY SYSTEMS

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. Section includes common requirements for IT & Security Systems.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. The publications listed below form a part of this specification. The publications are referred to in the text by basic designation only.

C. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean reference to the latest printed edition of each.

D. Conflicts
   1. Should an instance occur in this Specification or on the Drawings in which material or construction methods called for is less than minimum requirement of the reference standards, immediately inform the Engineer in writing. Consequent to Engineer's approval, supply the materials and perform the work as though called for to minimum code standards.

E. Referenced Standards
   1. International British (BS), European (EN) and IEC Standards which are in relationship with each other, tackle the same topic and carry the same number, can be used interchangeably in this specification since they are assumed to have the same intent and target the same level of quality and safety. For example: BS EN 60529 and IEC 60529. This shall be applicable to all subjects except for life safety related materials and systems (such as the Fire Alarm System) whereby BS EN shall remain mandatory.

F. Codes and Standards: All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:
   1. Comply with the latest issue of several material and test standards, which have been developed and published by Institute of Electrical and Electronics Engineers (IEEE) for data communications industry, but not limited to:
      a) 802.1 – LAN/MAN Bridging and Management,
      b) 802.3 – Carrier Sense Multiple Access/Collision Detection Access Methods (Ethernet),
      c) 802.11 – Carrier Sense Multiple Access/Collision Avoidance Access Methods (Wireless LAN's),
   2. ISO/IEC/IEEE 24765, Systems Software Engineering - Vocabulary.
   3. Comply with the latest issue of several material and test standards, which have been developed and published by Network Equipment Building System (NEBS). Level 1, Level 2, and Level 3 are applicable to this Section:
      a) SR-3580: NEBS: Criteria Levels.
      b) GR-63-Core: NEBS: Physical Protection.
      c) GR-1089-Core: NEBS: EMC and Electronic Safety.
      d) GR-3160: Data Centers.
   4. Internet Engineering Task Force (IETF).
   5. International Organization for Standardization (ISO).
   6. European Directives:
      a) European Low Voltage Directive (LVD): 2014/35/EU.
      b) European Radio Equipment Directive (RED) 2014/53/EU.

c) Directive on Waste Electrical and Electronic Equipment (WEEE) 2012/19/EU.

7. Electrical equipment, devices and components shall comply with the appropriate Class for project environment as per requirements of EMC:
   a) EN 61000-6-1, Electromagnetic compatibility (EMC). Generic standards. Immunity for residential, commercial and light-industrial environments.
   b) EN 61000-6-3, Electromagnetic compatibility (EMC). Generic standards. Emission for residential, commercial and light-industrial environments.
   c) EN 61000-6-2, Electromagnetic compatibility (EMC). Generic standards. Immunity for industrial environments.
   d) EN 61000-6-4, Electromagnetic compatibility (EMC). Generic standards. Emission for industrial environments.
8. Power Quality
   a) EN 61000-3-2: Electromagnetic compatibility (EMC) - Part 3-2: Limits - Limits for harmonic current emissions (equipment input current ≤ 16 A per phase).
   b) EN 61000-3-3: Electromagnetic compatibility (EMC) - part 3-3: limits - limitation of voltage changes, voltage fluctuations and flicker in public low-voltage supply systems, for equipment with rated current ≤ 16 A per phase and not subject to conditional connection.
9. Information Technology equipment, devices and components shall comply with the appropriate Class for project environment as per requirements of EMC:
   a) EN 55035, Electromagnetic compatibility of multimedia equipment. Immunity requirements
   b) EN 55032, Electromagnetic compatibility of multimedia equipment. Emission Requirements.
10. And / Or Electrical and Information Technology equipment, devices and components shall comply with the appropriate Class for project environment as per requirements of EMC:
    a) Code of Federal Regulations: 47 CFR - Telecommunication, Chapter I - Federal Communications Commission, Part 15 - "Radio Frequency Devices."
11. Safety
    a) IEC 62368-1, Audio / video, information and communication technology equipment. Safety requirements.
    b) IEC 62368-3, Audio / video, information and communication technology equipment. Safety aspects for DC power transfer through communication cables and ports.
    c) IEC 60950-1, Information technology equipment. Safety. General Requirements.
    d) IEC 60950-22, Information technology equipment. Safety. Equipment to be installed outdoors.
12. All electrical works shall comply with the local Electricity Regulations. Refer also to Division V, Section “Basic Electrical Materials and Methods”.

G. System software, terminology, and modeling of Integration Systems shall be compliant with ANSI/ISA-95 (S95).

H. Local regulations and standards, where enforced and relevant, are to have precedence over the Standards.

110.020 PROJECT/SITE CONDITIONS

A. Environmental Conditions: to be developed

B. Operational Constraints: The SYSTEM will run 24 hours per day, all the days of the year.

C. Unless otherwise indicated**,** 25%spare capacity shall be required at all levels of the SYSTEM.

D. Power Supply
   1. Power supply for all products shall be supplied or derived from the voltage system described below, as shown on the Drawings, or as otherwise specified.
   2. Nominal characteristics of power supply and distribution system (AC voltage / No. of Phases / Frequency / Earthing system) shall be as per local country standard. For details, refer to Division V, Section “Basic Electrical Materials and Methods”.

110.030 DEFINITIONS AND ABBREVIATIONS

A. Definitions
   1. SYSTEM: The IT or Security System to which these Specifications apply.
   2. Virtual Server Environment (VSE): An environment that runs multiple independent operating systems on a single physical computer. In a VSE, a single physical server may be divided into multiple logical servers.

B. Abbreviations: to be developed

120.000 SYSTEM DESCRIPTION

120.010 SCOPE OF WORK

A. The Contractor shall provide, based on these specifications and design drawings, the final design and construction documents and all equipment, software, material, labor and services required to construct and install the SYSTEM infrastructure including, but not limited to:
   1. All design services, drawings and specifications, equipment, software, materials, labor and services, not specifically mentioned or shown, which may be necessary to complete the design and installation of the SYSTEM.
   2. Proposal to upgrade the specified systems to the latest technology available, so as to bring the specified items to the prevailing technology at the time of construction as detailed in Article "Quality Assurance" of this Specification Section.
   3. Hardware as specified for the system and any hardware that is specific to the Contractor's proposed system.
   4. Software application and any other software that may be required to make the system fully operational as specified including the provision of network management software, IP addresses, setup and configuration and any other required configuration.
   5. Installation and setup of the system hardware and software as specified.
   6. Coordination with the Service Providers of interfaced systems.
   7. Integration of the SYSTEM with other systems and in coordination with the Employer.
   8. Risk analysis of system design showing advantages and drawbacks.
   9. Post deployment auditing.
   10. Delivery of the "Interface Control Document - ICD".
   11. Final connection of hardware to power, infrastructure termination and patch cords connecting system equipment to the data outlets and other network communication equipment.
   12. Documentation: Licenses, Shop drawings, Specifications, As-built drawings, user's manual, operation and maintenance manuals, test reports, etc.
   13. Handover manufacturer's recommended spare parts (along with current unit prices) for all major components in the system for two (2) years fault-free operation.
   14. Handover manufacturer's recommended test equipment and tools (along with current unit prices) required for system maintenance.
   15. Test plan.
   16. System testing and commissioning.
   17. System roll-out.
   18. System warranty as specified herein.
   19. Training as specified herein.
   20. Maintenance and support as specified herein.
   21. Supply the licenses for all software, programs and modules provided for the works including those developed and modified by the Contractor. The appropriate licenses supplied by the Contractor shall enable the Employer to use, modify, and develop the software, programs and modules for the works supplied under this Contract.

B. Systems Integration

   a) To be developed.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. General
   1. Drawings and general provisions of the Contract, including Project "Preliminaries and General Requirements", apply to this Section.
   2. All the requirements presented in this Specification "Common Clauses for IT & Security Systems" shall be complimentary to and shall apply to the following SYSTEMS except where a particular SYSTEM Specification calls for otherwise. In this case, the individual SYSTEM Specification shall have precedence.

      a) IT Systems
      b) Security Systems
      c) Other Communications Systems

B. Related Sections:

      a) Electrical sections
      b) Other related sections

210.000 RELATED PRODUCTS

210.010 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. To be developed as per design requirements

210.020 SIGNAL TRANSMISSION COMPONENTS

A. To be developed as per design requirements

210.030 CONDUITS, TRUNKING, ENCLOSURES AND FITTINGS
   1. To be developed as per design requirements

PART 3 PRODUCTS AND WORKMANSHIP

300.000 PRODUCTS

300.010 MANUFCATURERS

A. To be developed

300.020 PROPOSED SOLUTION

A. The Contractor shall use well-proven technologies with a demonstrated history of operation in a live airport environment.

B. The proposed solution shall be already available in use on other Projects of similar application and comparable size.

C. System and applications software shall be controlled and configured by working parameters stored in tables and easy to change without programming.

D. The system shall be easy to deploy throughout the whole Project.

E. The system shall be able to accept multiple devices of different types, technologies and manufacturers.

F. The proposed solution shall conform to each SYSTEM specification.

G. The Contractor shall ensure that the system does not cause any interference to other systems.

300.030 NETWORK EQUIPMENT

A. General
   1. System Architecture shall be based on a "Client-Server" configuration.
   2. System software shall be controlled and configured by working parameters stored in tables and easy to change without programming.

B. Servers
   1. The Contractor shall design Servers architecture to fulfil, as a minimum, the following requirements:

      a) Separation of database and application servers.
      b) Dual-redundant servers in clusters for high availability.
      c) Servers located in separate rooms for disaster recovery.
   2. Servers Configuration:

      a) The servers shall consist of dual, redundant servers. The intent is to prevent a single system point of failure.
      b) The servers shall be identical, with one server acting as the primary and the second server acting as a hot stand-by server with automatic fail over capabilities.
      c) The two servers shall maintain synchronized databases automatically. Upon loss of communication of the system with the primary host, the secondary server shall automatically assume the control of the system and become the primary server. Upon the re-establishment of communication with the server, the two servers shall automatically re-synchronize without requiring re-booting of the servers.
   3. The Contractor shall design servers that are able to cope with the foreseen workload:

      a) The Contractor shall indicate the percentage increase of workload that the servers will be able to cope with.
   4. The Contractor shall **[deliver and]** configure the required servers.

      a) Requirements for servers shall be given (in terms of operating system, memory, CPU, storage, associated peripheral I/O devices, etc.)

      b) The Contractor shall include servers under the Project Virtual Servers Environment.

      c) Requirements for servers shall be coordinated with the Virtual Servers Environment Contractor. Refer to Division W, Section “Virtual Servers Environment (VSE)”.

C. End Users' Clients
   1. The Contractor shall provide workstations on which the client will be able to operate.
   2. Main characteristics shall be given in terms of Memory, CPU, Screen size, resolution, etc.
   3. The Contractor shall deliver and configure required workstations.
   4. The following peripheral I/O devices shall be provided at the workstations and terminal/data servers:

      a) Keyboard and mouse
      b) Flat panel LCD video display unit.
   5. All PC’s shall be the latest model at the time of purchase and shall be sourced from a recognized manufacturer. Purchase of the PC’s shall be delayed until the latest time possible without causing a delay in the construction schedule to ensure that they will be state-of-the-art, based on the latest proven technology.

D. Equipment Mounting: to be developed

E. Specifications of servers, workstations, printers and associated peripherals shall be confirmed by the relevant SYSTEM manufacturer/supplier.

F. To be developed.

310.000 QUALITY MANAGEMENT

310.010 PRODUCTS AND WORK BY OTHERS / COORDINATION

A. Refer to SYSTEM Specifications Sections listed under Article “Related Documents” of this Specification Section for requirements.

310.020 CONFIDENTIALITY

A. The Contractor shall respect and protect the privacy and confidentiality of the Employer, his employees, processes, products, and intellectual property to the extent necessary, consistent with the legal responsibilities of the Employer policies.

B. Contractor shall sign a non-disclosure agreement and abide by the requirements to keep confidential all information concerning bid documents and this Project.

310.030 QUALITY ASSURANCE

A. Materials and Equipment
   1. To be developed

B. Manufacturer Qualifications
   1. To be developed

C. Contractor's Qualifications
   1. To be developed

310.040 DELIVERY, STORAGE AND HANDLING

A. Comply with Project "Preliminaries and General Requirements".

310.050 WARRANTY

A. Special Warranty
   1. The SYSTEM (comprising any associated hardware and software) shall be warranted by the Manufacturer to be free from defects in equipment, software and workmanship for a period defined below in paragraph "Warranty Period".
   2. Manufacturer's Warranty: Provide written warranty, signed by the Manufacturer and the Installer agreeing to replace system devices and equipment that fail in materials or workmanship and to provide software patch support and updates within specified warranty period.
   3. To maintain the manufacturer's warranties, equipment shall be installed, commissioned and serviced by those installers authorized by said manufacturer to perform those duties. If the Contractor is not authorized, by the said manufacturer, it is his sole responsibility to make the appropriate arrangements and bear all cost and consequences thereof.
   4. All manufacturers' equipment warranties shall be activated in the Employer's name and shall commence on the date indicated in paragraph "Warranty Period" below.

B. Experimental Period
   1. There shall be an Experimental Period during which the Contractor shall undertake supervision and responsibility for operation of the SYSTEM under actual site conditions. If any malfunction or degradation in the performance is noted on the system during this period, it shall be attended to immediately.
   2. During this period, the Contractor shall fully demonstrate the system performance under actual operation conditions. This demonstration is to confirm, to the satisfaction of the Employer / Engineer that the SYSTEM is free of remarks and is ready for taking over.
   3. The Experimental Period shall extend over three months and shall start following the certification by the Engineer of the successful testing and commissioning of the system. The Experimental Period shall, each time a malfunction is detected, be extended by three months starting from the certification by the Engineer of the successful testing of the system following the rectification of the malfunction.

C. Taking Over of the System
   1. The system shall be considered ready for taking over by the Employer following:
      a) The expiry, with no malfunctions being detected during the last three months, of the Experimental Period (as may be extended), and
      b) The submission by the Contractor, and approval by the Engineer, of the documents and information required from the Contractor for the use, occupation and maintenance of the system in accordance with the Contract (updated as necessary to reflect any rectification(s) introduced during the Experimental Period).

D. Warranty Period
   1. The Contractor shall include a statement of warranty on the entire system and on the individual pieces of equipment for two years from the date of taking over of the system.
   2. During the Warranty Period, the Contractor shall undertake Maintenance actions as defined in the “Maintenance And Support During Warranty Period” Article of this Specification Section.
   3. During the Warranty Period, the Contractor shall provide all equipment, material, software and labor needed to replace or repair defective products without any additional cost to the Contract.
   4. Warranty period shall be revised in accordance with Project “Preliminaries and General Requirements” depending on Equipment Country of Origin.

310.060 COMMISSIONING

A. Generally accepted industry standards, as well as manufacturer's written installation instructions, will be used as a basis for quality control and final acceptance of the works.

B. In-System Commissioning
   1. Equipment commissioning shall be done through demonstration of product capability and compliance with requirements after being wired and configured in the system.
   2. Test system and power supply redundancies by unplugging redundant links.
   3. Check recovery times.

C. The Contractor shall be required to perform a range of Site Acceptance Tests on site for each individual sub-system to demonstrate that all items have been correctly installed and adjusted on a location by location basis and that the sub-system operates in every respect in accordance with the Specifications.
   1. During this commissioning phase, the equipment is powered and the automation and networking are gradually integrated layer by layer.
   2. Any defects, which may become apparent during the course of these tests, shall be immediately rectified by the Contractor at his expense.
   3. The Site Acceptance Test Specifications shall be prepared by the Contractor and submitted for Approval by the Engineer and Employer.
   4. All Site Acceptance Tests shall be carried out in the presence of the Employer who shall sign off the testing documentation on satisfactory completion of the tests.
   5. The Site Acceptance Test Specifications shall at every level, be subjected to configuration management and change control by the Contractor.
   6. If modification or reprogramming is required as a result of the tests, all affected parts of the Site Acceptance Tests, as determined by the Employer, shall be re-tested.
   7. The results of the Site Acceptance Tests, version of software and hardware tested, together with any re-testing as a result of failure, shall be recorded and signed by the authorized personnel of the Contractor and the Employer.

D. Those tests shall be carried out over two phases.
   1. Preliminary Testing:
      a) Mechanical:
         1) Mechanical tests,
         2) Calibration of the components.
      b) Automatism / Electrical:
         1) Powering Tests with electricity,
         2) Control of Input/Output,
         3) Control of the safety measure either personal or material,
         4) Test of local mode operation.
      c) Network / Software Tests:
         1) Test of the Network,
         2) Test of the Supervision Workstation user interface,
         3) Test of the portable Terminal user interface.
   2. System Testing
      a) The tests performed during this phase are performed with and without loading conditions.

1) Testing the crippled mode (Safe shut down consecutive to loss of energy, etc.).

310.070 MAINTENANCE AND SUPPORT DURING WARRANTY PERIOD

A. Support
   1. The Contractor shall offer a comprehensive explanation of its Service Level Agreement (SLA) policy. The SLA should cover at least the following performance terms:
      a) 99.999% availability. GTI and GTR should be guaranteed accordingly.
      b) Emergency level 24/24, 7/7 phone support shall be available. Distant intervention on system shall be offered.
      c) High-level problem investigation support shall be offered 5/7 during working hours.
      d) Maintenance stocks shall be properly sized by the Contractor in order to match operational quantities replacement needs based on Manufacturers MTBFs for each component within the network.
      e) The MTTR shall not exceed 30minutes. The MTTR shall include the diagnostic time, active repair/replacement time and the adjustment/testing time on site, but shall exclude the response time.
   2. Maintenance service shall include:
      a) Contract lifetime software patching for revealed problems during operations.
      b) Contract lifetime hardware replacements on established malfunctions or weaknesses generating repetitive loss of service quality.
      c) Following receipt of a defective product, Manufacturer shall make reasonable efforts to repair or replace equipment with new ones and return the equipment within a reasonable time not exceeding four working days.

B. Maintenance Service
   1. During the Warranty Period, Manufacturer or factory-authorized agency shall maintain a service center capable of providing spare parts and emergency maintenance and repairs for the overall system at Project site 7 days a week and 24 hours a day. Competent personnel shall be dispatched to rectify stoppages at any time during the day or night when being called on by the Employer.
   2. The Contractor shall submit a Service-Call Report to be sent to the Employer immediately following every call out, indicating the time of call out visit, cause, remedial action taken and the time that the service was restored.
   3. A Maintenance Manpower Plan shall demonstrate the Contractor's committed resource level available for all types of activities to be carried out within the Warranty Period. Such a plan shall be submitted for Approval six months before commencement of the Warranty Period.
   4. The Contractor's response time, during the Warranty Period, shall not exceed 1 hour. The response time is defined as the time that elapses between the reporting of a fault and the maintenance personnel arriving at where the faulty equipment is located.
   5. During the Warranty Period, the MTTR shall not exceed **[30]** minutes. The MTTR shall include the diagnostic time, active repair/replacement time and the adjustment/testing time on site, but shall exclude the response time.
   6. During the Warranty Period, the monthly average of the Repair Time shall be lower than or equal to 6 minutes for each device. This performance will be monitored.
   7. The Contractor shall provide at least four inspection visits at six-month interval during the Warranty Period.
   8. The Contractor shall submit a Service-Call Report to be sent to the Employer immediately following every inspection visit, indicating the time of call out visit, cause, remedial action taken – if any - and the time that the service was restored.
   9. The Contractor shall be responsible for clearing away from the Site all surplus materials, rubbish, temporary works of every kind and leaving Project Site and installation clean and in a workmanlike condition to the satisfaction of the Employer /Engineer, upon completion of repair, and maintenance works.

C. Maintenance Performance Data
   1. Updates

a) The SYSTEM will have to be conceived to facilitate the updates that will take place throughout its life. Software update process must be easy, rapid and without risk, and must be reversible.
b) Update shall be transparent to the user and shall be done without interruption of the service.

2. Corrections

a) In the event of error, the SYSTEM shall have, as soon as possible, to store in a file a certain amount of information allowing the correction of this error, e.g. entries in the transactions, faulty operations of the statistics, etc.

3. The Contractor commits himself to the three (3) main sizing data of maintenance:

a) Annual number hours of preventive maintenance.
b) Annual number hours of corrective maintenance.
c) Average Annual cost of spare parts (Average based on ten years).

D. Preventive Maintenance
1. The Contractor shall describe the selected operations for preventive maintenance as planned during daily operation.

E. Curative Maintenance
1. The selected operations shall be chosen to correspond to a significant fraction of the forecasted time devoted to curative maintenance.
2. For each defect incidence, the Contractor shall record:

a) Equipment identification.
b) The object of the Maintenance activity.
c) The type of Maintenance activity (planned or not).
d) The total man-hours spent for the activity.
e) The total down-time duration ascribable to the Maintenance activity (transportation time, diagnosis time, repair time, restart time).

310.080 SPARE PARTS AND EXTRA MATERIAL

A. The manufacturer shall guarantee the flow and availability of the spare parts without a major design change for at least ten years' period from date of System Acceptance by Employer.

320.000 SUBMITTALS

A. The Contractor shall not perform any part of the work requiring submittal and review of shop drawings, product data or samples until Engineer / Employer has approved the respective submittal. Such work shall be in accordance with approved submittals:
1. Product data: For each type of product.
2. Shop Drawings.
3. Wiring diagrams to show typical wiring schematics.
4. System Operation: Include:

a) System Architecture and performance requirements.
b) Inter-connectivity patching of all network devices
c) Human Machine Interface (HMI) design for all categories of users.
d) Software Architecture and justification (e.g.: off-the-shelf and specific software, etc.).

B. Submittals shall comply with Project "Preliminaries and General Requirements".

C. Submittals shall include:
1. Product Certificates:
2. Manufacturer's Endorsement
3. signed Warranty.
4. Testing Plan:
5. Field Test Reports
6. Product data: For each type of product.
7. Shop Drawings
8. Qualifications
9. Closeout Submittals (Record Documents):
10. Operations and Maintenance Manuals

11. To be developed

330.000 EXECUTION

330.010 INSTALLATION

A. General
   1. All equipment shall be firmly secured in place unless requirements of portability dictate otherwise.
   2. Equipment is to be laid out properly in communication rooms in a way to reserve relevant space for maintenance activities. This space shall also account for any future expansion of the system.
   3. Installation shall be performed in accordance with the applicable standards, requirements, manufacturers' guidelines and any authorities having jurisdiction.
   4. All boxes, equipment, etc. shall be plumb and square.
   5. The Contractor shall take such precautions that are necessary to prevent and guard against electromagnetic interference.
   6. After the proper layout of all equipment is accomplished, all components are to be labeled, and marked
   7. During installation, consideration shall be given to operational efficiency as well as the overall aesthetic factors.
   8. The Contractor shall supply and install all fittings and accessories, whether or not specified, required for proper, safe, and reliable operation of the system.
   9. The Contractor shall ensure that safe ingress and egress from all work areas are maintained during movement and installation of equipment/materials.

B. Examination
   1. To be developed.

C. Rack Mounted Equipment
   1. To be developed.

D. Wiring Methods
   1. To be developed

E. Cleaning

F. To be developed Connections

G. To be developed Weatherproof Equipment
   1. To be developed.

H. Impedance and Signal Levels
   1. To be developed.

I. Labeling and Marking
   1. To be developed.

J. Firestopping
   1. To be developed .

K. Grounding
   1. To be developed.

L. Boxes and enclosures
   1. To be developed.

M. Push Buttons

330.020 TO BE DEVELOPED FACTORY ACCEPTANCE TESTS

A. The Factory Acceptance Tests shall be carried out in a hardware and software environment, which simulates the final configuration of the SYSTEM.

B. The Contractor shall carry out any Factory Acceptances Tests, in Manufacturer's factory itself, before any site delivery, in order to make sure that the SYSTEM of both hardware and software and

the SYSTEM after integration of various sub-systems is able to satisfy site technical requirements of the equipment specifications.

C. Test Plan
   1. All tests are to be carried out, according to the methodology presented in the Test Plan which has been submitted by the Contractor and approved by the Employer.
   2. The tests are to cover every aspect related to the specification of the SYSTEM and its operation; including, but not limited to, visual inspections, measurements, and operation.
   3. Some of the functional or performance tests, which cannot be conducted in a simulated environment, due to their nature and complications, may, subject to the Engineer's approval, be combined with the Site Acceptance Tests.

D. All Factory Acceptance Test Specifications shall be subject to configuration management and change control by the Contractor at every level.

E. The results of the Factory Acceptance Tests, together with any re-testing as a result of failure, shall be recorded and signed by the authorized personnel of the Contractor.

F. Witnessed Factory Acceptance Tests:
   1. FAT's for the following SYSTEMS shall be carried out in the presence of the Engineerand Employer unless otherwise agreed by the Engineer. The Engineer will sign off the testing document on satisfactory completion of the tests.

330.030 FIELD QUALITY CONTROL

A. Pretesting: After installation, align, adjust, and balance system and perform complete pretesting to determine compliance of system with requirements in the Contract Documents. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.
   1. Report of Pretesting: After pretesting is complete, provide a letter certifying that installation is complete and fully operable; include names and titles of witnesses to preliminary tests.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

D. Perform tests and inspections.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

E. Tests and Inspections:
   1. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
   2. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
   3. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

F. Record test results.

G. Retest: Correct deficiencies identified by tests and observations and retest until performance requirements are met.

H. Integrated Tests with Other Contractors
   1. to be developed

I. The SYSTEM will be considered defective if it does not pass tests and inspections.

J. Tag all equipment, stations, and other components at which tests have been satisfactorily completed.

K. Prepare test and inspection reports.

L. Experimental Period: As described under “Warranty” Article of this Specification Section. Demonstrate successful operation to confirm, to the satisfaction of the Engineer /Employer that the system is free of remarks and is ready for taking-over.

330.040 DEMONSTRATION AND TRAINING

A. Train Employer's maintenance personnel to configure, program, adjust, operate, and maintain SYSTEM equipment. Refer to Project “Preliminaries and General Requirements”.

B. In order to provide a reliable training, Employer’s maintenance personnel who are involved in the training program of this system, could be involved in the follow up of system installation as well. The Contractor shall provide an installation agenda to the Employer and confirm with him any coordination with assigned trainees.

C. Training Program
   1. Scope: Training shall be in sufficient scope to ensure that all trainees who complete the program will be certified as capable to operate and/or maintain the equipment, systems, and facilities provided and installed under this Contract, and to ensure a smooth transition between construction and operations activities.
   2. Language: to be developed
   3. Training Aids shall include:
      a) to be developed
   4. Training Manuals
      a) To be developed
   5. Training shall be performed in accordance with an approved training program. All training aids shall be available and approved prior to start of training.
   6. Course Contents
      a) To be developed

D. The Contractor shall provide training for SYSTEM operational, maintenance and administration staff:
   1. Operators shall be provided with a thorough training in all aspects of system/sub-system operation under both normal and abnormal conditions. This training shall include, but not be limited to:
      a) Orientation to provide overview of system/sub-system purpose, configuration, and operations,
      b) Terminology,
      c) Operations theory and interface,
      d) Equipment appearance, functions, concepts and operations,
      e) Operating mode, practices, and procedures under normal and emergency conditions,
      f) Safety precautions,
      g) On-the-job operating experience covering all system/sub-system operating functions, activities, and tasks including those associated with degraded operating modes, failure recognition, and recovery processes,
      h) Familiarity with content and use of O & M manuals and related reference publications.
   2. Maintenance Training
      1) To be developed
   3. Administrator Training
      1) To be developed.

W31B - WIRELESS DATA NETWORK

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. Section includes Wireless Data Network active infrastructure and associated services consisting of:

1. Wireless Radio Access Points and Antennas.
2. Wireless Data Network System Administration Software.
3. Access and Security Control Software.

100.020 PERFORMANCE REQUIREMENTS

A. To be developed.

B. Provide pervasive wireless coverage across all designated airport zones. This includes terminals, gates, lounges, retail, staff areas, baggage zones and airside operational zones. Ensures seamless connectivity for passengers, staff and airport systems.

C. The Contractor shall deploy a centralized Wireless LAN Controller (WLC) based architecture. It shall support access points across the project. Centralized control allows consistent policy enforcement and scalable RF management.

D. Adopt latest Wi-Fi technology standards Wi-Fi 7. Ensure high throughput, low latency, improved spectral efficiency and support for high-density environments. The system shall be capable to meet current and future demands for passenger and IoT device connectivity.

E. Install high-performance indoor and outdoor access points to provide dual-band (2.4GHz and 5GHz) and tri-band (6GHz) coverage with dynamic channel selection and automatic RF tuning. Shall provide optimized coverage, reduced interference and higher client concurrency.

F. Provide mounting hardware required for access point installation. Align with Architecture.

G. Implement enterprise wireless security. This includes WPA3 encryption, 802.1X authentication, dynamic VLAN assignment, and integration with Network admission control systems. This ensures role-based access, secure onboarding and compliance with cybersecurity policies.

H. Implement with a centralized orchestration tool for real-time visibility, troubleshooting, and lifecycle management of the WLAN system.

I. Design with cluster of wireless LAN controllers and dual uplinks for access points where applicable. Ensuring failover and minimal downtime.

J. Plan for peak density usage. Ensure the sufficient access point placement and backhaul capacity to support high client loads. It includes passengers, staff devices and IoT sensors. Design shall meet the reliable performance during high-traffic conditions or events.

K. Follow guidelines from the Radio Systems Approvals Board for spectrum usage, RF power limits, and access point placement coordination. Shall prevent interference and ensures regulatory compliance across the project.

L. Shall provide detailed design documentation, including high-level and low-level design documents, access point heatmaps and signal coverage maps, equipment layout and termination plans, equipment schedules and bill of quantities.

M. Provide a WLAN system that is capable of large-scale IoT onboarding, and AI/ML-driven optimization features.

N. Perform complete wireless validation surveys, load testing, and system commissioning during deployment. Ensure that wireless coverage and performance meet the design intent and operational requirements.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Comply with: PCI DSS, The Payment Card Industry Data Security Standard.

110.020 PROJECT/SITE CONDITIONS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

110.030 DEFINITIONS AND ABBREVIATIONS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Definitions

1. “OFE”: shall refer to “Owner Furnished Equipment”, which will be provided by the Owner/Employer. The Contractor shall be responsible for removing this equipment from the Owner’s premises, and re-installing and integrating this equipment in good working order where required and detailed in these Specifications.
2. Wireless Radio Access Point: equipment interfacing over the air between the data network fixed network and the mobile end users.
3. Wireless Terminal Client: equipment integrated or connected to the end user terminal equipment that enables data transmission over the air to the Wireless Data Network. This terminal client can be a Wi-Fi enabled PC, PDA or specialized handset (e.g. scanner, customized PDA), etc.
4. Antenna: equipment attached to the Radio Access Points in order to amplify the RF signal to/from the Access Point, and to point the RF signals to specific coverage areas. These antennas can be omni-directional or directional.
5. Wireless Data Network System Administration Software: software installed on a dedicated platform and enabling the operation and maintenance of the Radio Access Points.
6. Access Control Function Software: software installed on a dedicated platform and enabling:

    a) The control of the users authorized on the Wireless Data Network.
    b) The centralized management of the rights of the Wireless Data Network users.
    c) The configuration of the security components of the network (authentication, encryption, VLANs).

120.000 SYSTEM DESCRIPTION

120.010 SCOPE OF WORK

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

120.020 SYSTEM DESCRIPTION

A. Overview of Project Environment and Requirements

B. To be developed

130.000 CONTROL REQUIREMENTS

130.010 INTEGRATION REQUIREMENTS

A. Network Interfaces

1. To be developed

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. General

1. Refer to Division W, Section W31 “Common Clauses for IT & Security Systems”.

B. Related Sections

1. To be developed

210.000 RELATED PRODUCTS

210.010 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

PART 3 PRODUCTS AND WORKMANSHIP

300.000 PRODUCTS

300.010 MANUFACTURERS

A. To be developed

300.020 SYSTEM ARCHITECTURE AND REQUIREMENTS

A. To be developed

B. The purpose of the Wireless Data Network is to provide users with a complete high-performance radio system that enables secure access to information systems within the Project premises. Users of the system are authorized individuals who will access internet, enterprise resources and applications through the Wireless Data Network. The infrastructure shall support various user communities. Dedicated VLANs dynamically or statically assigned to each community as per security and QoS policy.

C. The Wireless Access Point shall include integrated IoT radios with onboard Bluetooth Low Energy (BLE) 5.1 or higher and Ultra-Wide Band (IEEE 802.15.4ab). These radios shall support the deployment and centralized management of IoT-based services, including location-based services, asset tracking, environmental sensors, and physical security applications.

D. The Access Point shall function as a converged IoT gateway, supporting modular wireless expansion through an onboard USB 3.0 port, enabling seamless integration of emerging technologies.

E. The system shall be fully compatible with IEEE 802.11 standards. It shall include a/b/g/n/ac/ax and be. It shall be backward compatible with legacy clients while offering enhanced features for next-generation devices.

F. The system shall include support for enhanced protocol extensions. It shall include IEEE 802.11d (regulatory domain awareness), IEEE 802.11e (Quality of Service) and IEEE 802.11i (WPA2/WPA3 security framework).

G. The system shall support simultaneous operation across all bands for IEEE 802.11a/b/g/n/ac/ax clients. It shall ensure universal connectivity across device generations.

H. The system shall support the IEEE 802.11be (Wi-Fi 7) standard. Ensure to provide following minimum feature support

1. Tri-band operation (2.4 GHz, 5 GHz, 6 GHz)
2. 320 MHz channel bandwidth
3. Multi-Link Operation (MLO) for concurrent multiband communication
4. 4096-QAM modulation
5. 16 spatial streams (where supported)
6. Extremely low latency and high reliability for mission-critical applications

I. The system shall be PCI DSS compliant. It shall support robust encryption standards (WPA3-Enterprise, 256-bit AES-GCMP) and secure management protocols. And ensure regulatory and data protection compliance.

J. The Wireless LAN infrastructure shall provide seamless wireless coverage across the entire Campus. The systems shall provide full functionality for high-density and low-latency services such as data access, voice over WLAN, video streaming, IoT telemetry and augmented reality applications.

K. 25% spare capacity is required at all levels of the system, unless indicated otherwise.

L. The software licensing shall be for the entire network with no limitation on the number of workstations or standard end-users plus an allowance of 25% additional licenses to accommodate future growth.

M. The system shall serve the Passenger and Asset tracking through RTLS.

N. Data Network Performance and Software Requirements of the Project: Refer to Division W, Section "Data Communications for Campus Network" and Section "Data Communications for Data Center".

300.030 SYSTEM COMPONENTS

A. Wireless Data Network Controllers:

1. To be developed

B. Wireless Radio Access Points

1. To be developed

C. Antennas

1. To be developed

D. Wireless Data Network Administration Software System

1. To be developed

E. Enclosures

1. To be developed

F. Access and Security Control Software System

1. To be developed

300.040 SOFTWARE ARCHITECTURE

A. The network shall be partitioned among the different user populations and applications using multiple VLAN (Virtual Local Area Network).

B. The user authentication process shall rely on IEEE 802.11i and 802.1X standard and shall follow the Employer requirements, taking into account the expected security level of each network and data package.

300.050 FREQUENCY PLANNING

A. Multi-cellular radio architecture shall be adapted to the local standards regulation with proper frequency planning.

300.060 TECHNICAL STUDY

A. Preliminary Study

1. To be developed

B. Final Study

1. To be developed

C. Refer to Division W, Section “Common Clauses for IT & Security Systems”, Articles “Proposed Solution” and “Network Equipment”.

300.070 GENERAL SOFTWARE REQUIREMENTS

A. Levels and Features to be developed

B. Refer to Division W, Section “Common Clauses for IT & Security Systems”, Articles “Proposed Solution” and “Network Equipment”.

310.000 QUALITY MANAGEMENT

310.010 PRODUCTS AND WORK BY OTHERS / COORDINATION

A. To be developed

310.020 CONFIDENTIALITY

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

310.030 QUALITY ASSURANCE

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

310.040 DELIVERY, STORAGE AND HANDLING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

310.050 WARRANTY

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

310.060 COMMISSIONING

A. Generally accepted industry standards, as well as manufacturer's written installation instructions, will be used as a basis for quality control and final acceptance of the work.

B. To be developed

310.070 MAINTENANCE AND SUPPORT DURING WARRANTY PERIOD

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

310.080 SPARE PARTS AND EXTRA MATERIAL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

320.000 SUBMITTALS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

330.000 EXECUTION

330.010 INSTALLATION

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Installation of Wireless Access Points

1. To be developed

C. Installation of Antennas

1. To be developed

D. Installation of the Wireless Data Network System Administration Software

1. To be developed

E. Installation of the Wireless Data Network Access and Security Control Software

1. To be developed

330.020 FACTORY ACCEPTANCE TESTS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

330.030 FIELD QUALITY CONTROL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

330.040 DEMONSTRATION AND TRAINING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

W31C - VIRTUAL SERVERS ENVIRONMENT (VSE)

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. Section includes performance requirements and system architecture for a Virtualized Servers Environment to be deployed.

B. The Virtual Servers Environment (VSE) shall support the following applications:

1. Security Systems
    a) To be developed
2. Miscellaneous Electrical and Telecom Systems
    a) To be developed.
3. Horizontal and Vertical Transportation Systems
    a) To be developed.

100.020 PERFORMANCE REQUIREMENTS

A. Virtual Servers Environment infrastructure architecture shall be designed to ensure that the following performance criteria are consistently met or exceeded.

1. Operating Systems
    a) To be developed.
2. Availability
    a) To be developed.
3. Fault Tolerance
    a) To be developed.
4. Scalability
    a) To be developed.
5. Disaster Recovery
    a) To be developed.
6. Backup And Recovery
    a) To be developed.
7. Storage
    a) To be developed.
8. Capacity
    a) To be developed.
9. Security
    a) To be developed.

B. General Software Requirements

1. To be developed.

C. General Design Considerations

1. To be developed.

D. Software Expansion Requirements

1. To be developed.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

110.020 PROJECT/SITE CONDITIONS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

110.030 DEFINITIONS AND ABBREVIATIONS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Definitions

1. Virtualization is a method of running multiple independent virtual operating systems on a single physical computer. It is a way of fully utilizing physical resources available in modern powerful servers.
2. To be developed.

C. Abbreviations

1. LDAP: Lightweight Directory Access Protocol
2. TOE: TCP Offload Engine

120.000 SYSTEM DESCRIPTION

120.010 SCOPE OF WORK

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

120.020 SYSTEM ARCHITECTURE

A. Virtual Servers Environment system architecture shall consist of the following components:

1. Host computers.
2. Virtual Machines.
3. Virtualization host computers.

B. Contractor’s detailed design shall:

1. Accommodate the constraints and demands of the virtual machines, virtualization host computers, networking, and storage.
2. Meet all technical criteria for the specified server farm in a production environment.
3. Consider operations support, ongoing maintenance activities and future upgrades.
4. Support the immediate and long-term business Project requirements to accommodate future changes.

C. As a starting point, and to successfully plan for a virtual environment, Contractor may apply the requirements for a physical environment to the virtual environment. This includes elements such as farm topology, capacity and performance requirements, availability and disaster recovery to preserve business continuity.

D. Contractor may use a number of database servers, front end web servers, and application servers, including specific application server roles, to determine the number of virtual machines and virtualization host server computers that a virtualized farm requires.

E. The optimum number and capacity of system components will help maintain better load balancing and provide more availability for the particular farm role

F. To be developed

130.000 CONTROL REQUIREMENTS

130.010 INTEGRATION REQUIREMENTS

A. To be developed

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. General

1. Refer to Division W, Section W31 “Common Clauses for IT & Security Systems”.

B. Related Sections

1. To be developed

210.000 RELATED PRODUCTS

210.010 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

PART 3 PRODUCTS AND WORKMANSHIP

300.000 PRODUCTS

300.010 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but not limited to:

1. To be developed

300.020 VIRTUALIZATION TECHNOLOGY

A. Licensing: To be developed

B. Virtualization Environment The virtualization solution shall be capable of virtualizing, aggregating and allocating servers, storage and network resources precisely on demand and business priority

C. Server Virtualization: To be developed

D. Centralized Management: To be developed

E. Thin Provisioning: To be developed

F. Data Recovery: To be developed

300.030 SERVERS AND CONNECTIVITY

A. Objectives

1. The Contractor shall implement a robust and versatile blade and rack mount architecture that will enable and provide performance optimization, smaller power footprint, integration with and enhance virtualization among other things. To this effect, Contractor shall comply with the following minimum requirements:

B. Blade Servers

1. To be developed

C. SAN Switches

1. To be developed

D. Rack Mount Server: the servers shall support

1. To be developed

E. Blade Management Integration

1. To be developed

300.040 DESIGN PROCESS

1. To be developed

300.050 GENERAL HARDWARE REQUIREMENTS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”

B. To be developed

300.060 GENERAL SOFTWARE REQUIREMENTS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”

B. To be developed

310.000 QUALITY MANAGEMENT

310.010 PRODUCTS AND WORK BY OTHERS / COORDINATION

A. To be developed

310.020 MISCELLANEOUS QUALITY MANAGEMENT TOPICS

A. For the following quality management topics, refer to Division W, Section “Common Clauses for IT & Security Systems”:

1. CONFIDENTIALITY
2. QUALITY ASSURANCE
3. DELIVERY, STORAGE AND HANDLING
4. WARRANTY

310.030 COMMISSIONING

A. To be developed

310.040 MAINTENANCE AND SUPPORT DURING WARRANTY PERIOD

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

310.050 SPARE PARTS AND EXTRA MATERIAL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

320.000 SUBMITTALS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

330.000 EXECUTION

330.010 INSTALLATION

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Coordination

1. To be developed

330.020 FACTORY ACCEPTANCE TESTS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

330.030 FIELD QUALITY CONTROL

A. To be developed

330.040 DEMONSTRATION AND TRAINING

A. To be developed

W31D - COMPUTERS & RELATED PERIPHERALS

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. Section Includes:

1. Computers and related peripherals including but not limited to computer workstations, laptop computers and printers.
2. Servers and related ancillaries.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

110.020 PROJECT/SITE CONDITIONS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

110.030 DEFINITIONS AND ABBREVIATIONS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Definitions

1. PUE: Power Usage Effectiveness is a metric used to determine the energy efficiency of a data center. PUE is determined by dividing the amount of power entering a data center by the power used to run the computer infrastructure within it.

120.000 SYSTEM DESCRIPTION

120.010 SCOPE OF WORK

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

130.000 CONTROL REQUIREMENTS

130.010 INTEGRATION REQUIREMENTS

A. To be developed

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Refer to Division W, Section W31 “Common Clauses for IT & Security Systems”.

B. To be developed

210.000 RELATED PRODUCTS

210.010 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

PART 3 PRODUCTS AND WORKMANSHIP

300.000 PRODUCTS

300.010 MANUFACTURERS

A. To be developed

300.020 GENERAL HARDWARE REQUIREMENTS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”

B. To be developed

300.030 WORKSTATION EQUIPMENT

A. Computer Workstation – Type 1

1. To be developed

B. Computer Workstation - Type 2

1. To be developed

C. Computer Workstation - Type 3

1. To be developed

300.040 LED DISPLAYS

A. Workstation LED Display wide-screen Type 1

1. To be developed as per design requirements

B. LED Display Screen Type 2

1. To be developed as per design requirements

C. Video Wall- Type 1 for Control Rooms

1. To be developed as per design requirements

300.050 PORTABLE (LAPTOP) WORKSTATION EQUIPMENT

A. Laptop Computer Workstation

1. To be developed

300.060 PRINTERS/SCANNERS

A. Small office Black and White Laser Printer

1. To be developed

B. Small office Color Laser Printer

1. To be developed

C. Large workspace Color Laser Printer/Scanner

1. To be developed

300.070 SERVERS

A. To be developed

310.000 QUALITY MANAGEMENT

310.010 PRODUCTS AND WORK BY OTHERS / COORDINATION

A. To be developed

310.020 MISCELLANEOUS QUALITY MANAGEMENT TOPICS

A. For the following quality management topics, refer to Division W, Section “Common Clauses for IT & Security Systems”:

1. CONFIDENTIALITY
2. QUALITY ASSURANCE
3. DELIVERY, STORAGE AND HANDLING
4. WARRANTY
5. COMMISSIONING
6. MAINTENANCE AND SUPPORT DURING WARRANTY PERIOD

310.030 SPARE PARTS AND EXTRA MATERIAL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

320.000 SUBMITTALS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

330.000 EXECUTION

330.010 INSTALLATION

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Coordination: To be developed

330.020 FACTORY ACCEPTANCE TESTS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

330.030 FIELD QUALITY CONTROL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

330.040 DEMONSTRATION AND TRAINING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

W31F - DATA COMMUNICATIONS FOR CAMPUS NETWORK

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. Section Includes:

1. Data Communications for "Campus Network" equipment and software required to implement a fully operational data network:

a) Core Equipment: To be developed
b) Distribution (Border node) Equipment: To be developed
c) Access (Edge node) Switches: To be developed
d) Routers: To connect the LAN to external services and Wide-Area Network (WAN).
e) Firewalls: To be developed
f) Intrusion Detection: To monitor and alert on illegal access and sabotage attempts to the networks.
g) Intrusion Prevention: To monitor and thwart illegal access and sabotage attempts to the networks before they gain access to the network.
h) Network Management: To be developed
i) Out of Band and Field Devices Network Equipment: To be developed

2. The LAN shall include software and hardware components such as network equipment, network management software and hardware, network services and shall interface to electronic systems.
3. The proposed Wired and Wireless equipment shall support a Software-Defined Network Architecture.
4. The LAN system shall be designed to meet the initial operation requirements with the ultimate designed expansion capability to meet the requirements of future operational growth (in terms of number of ports and offered services) at project completion.
5. The LAN system final design and construction shall comply with the design intent as well as design specifications listed herein and associated drawings.
6. To be developed

100.020 PERFORMANCE REQUIREMENTS

A. Network Redundancy, Reliability and Availability

1. To be developed

B. Network design should be made to assure real time failure recovery. This is the reason why redundancy, reliability, and availability are required throughout the network using load balancing mechanisms and clustering techniques.

C. Since most Manufacturers have implemented proprietary optimizations for such purposes, detailed information on system performance shall be given by the Contractor.

D. Network Performance and Quality Of Service

1. To be developed

E. Network Security

1. To be developed

F. Network Scalability

1. To be developed

G. Equipment Connection

1. To be developed

H. To be developed

I. Software Requirements

1. To be developed

J. Design Considerations

1. To be developed

K. System Expansion Capacity

1. To be developed

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

110.020 PROJECT/SITE CONDITIONS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

110.030 DEFINITIONS AND ABBREVIATIONS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Definitions

1. “OFE”: shall refer to “Owner Furnished Equipment”, which will be provided by the Owner/Employer. The Contractor shall be responsible for removing this equipment from the Owner’s premises and re-installing and integrating this equipment in good working order where required and detailed in these Specifications.
2. "Turnkey System": a complete system of hardware and software delivered to the Employer ready-to-run.
3. PUE: Power Usage Effectiveness is a metric used to determine the energy efficiency of a Telecom Room/Servers Room. PUE is determined by dividing the amount of power entering a Telecom Room/Servers Room by the power used to run the computer infrastructure within it.

C. Abbreviations

1. Unicast RPF: Unicast Reverse Path Forwarding.
2. BYOD: Bring Your Own Device.
3. SDN: Software Defined Network.

120.000 SYSTEM DESCRIPTION

120.010 SCOPE OF WORK

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

120.020 SYSTEM DESCRIPTION

A. Overview of Current Environment and Requirements

B. The system architecture shall support multi-manufacturer interoperability with other manufacturer’s products and across any QoS infrastructure.

C. Each network shall be a multi-layer, fault tolerant, Layer-3 campus-wide TCP/IP network. The LAN hierarchy shall be based on three-tier architecture: access, distribution, and core. A high-bandwidth, Ethernet shall be utilized for core and distribution layer interconnectivity.

D. The Data Network active infrastructure shall be highly scalable, growing from a small amount of users up to the ultimate designed expansion capability to meet the requirements of future operational growth (in terms of number of ports and offered services) - at project completion. Although

implemented mainly for voice and data communications, the infrastructure shall be capable of multiple means of real time communication (voice, video, instant messaging, collaboration, etc.). The infrastructure shall provide high availability, redundancy, and contingency. The infrastructure shall be able to integrate with many other devices and applications, from existing voice infrastructure to new endpoints and applications.

E. To be developed

F. The system architecture shall provide bandwidth management and call admission control to guarantee at all times that the network and LAN/WAN links are not oversubscribed.

G. The system architecture shall support end-to-end QoS. This shall include, but not limited to, traffic marking, enhanced queuing services, link fragmentation and interleaving, CRTP, low latency queuing, link efficiency, traffic shaping, and call admission control.

H. Congestion management and multicast control, shall be implemented to manage real-time voice and video traffic as well as priority network data traffic. Other LAN/WAN services such as VLANs/VXLANs, Sub-netting, DNS, Proxies, Access Control Lists, DHCP and Routing Protocols shall be configured and implemented as part of the LAN solution. WAN connectivity to the internet and external services shall be secured using Firewalls and intrusion detection system.

I. The LAN shall be resilient and redundant with automatic fail-over to ensure that performance and high-availability objectives are met without manual intervention. Recovery mechanisms must be deployed as part of the network implementation and must be tuned to achieve sub-second recovery time. All switches shall be inter-connected and configured so that there is not any single point of failure causing disruptions to LAN operations. Technologies to minimize packet loss during Supervisor failure (such as Non Stop forwarding (NSF) and Stateful Switchover (SSO)) and in-service software upgrades (ISSU) shall be part of the devices specifications.

J. All network equipment shall be both IPV4 and IPV6 capable. While the specifications are based on IPV4, the Contractor , if directed by the Employer, shall implement IPV6 with backward compatibility to IPV4. Notwithstanding, the Contractor shall define all IP addresses static ranges and dynamic ranges as well as subnets and subnet masks.

K. [Connectivity to external services shall be accomplished using either asynchronous or synchronous services (e.g. E1, E3, OC-3 or OC-12) utilizing interfaces to external Service Provider SDH network in addition to SIP-trunk with all the required components (e.g. Session Border Controller).]

L. Network routing protocols shall be used as recommended including OSPF for internal networks and BGP for external networks.

M. A Network Management System (NMS) shall be provided as part of each Network to support around the clock 24/7 operation monitoring and management of all network devices and operations.

120.030 TECHNICAL STUDY

A. Preliminary study

1. To be developed

B. Final study

1. To be developed

120.040 GENERAL HARDWARE REQUIREMENTS

A. To be developed

B. Refer to Division W, Section “Common Clauses for IT & Security Systems”

120.050 GENERAL SOFTWARE REQUIREMENTS

A. To be developed

B. Refer to Division W, Section “Common Clauses for IT & Security Systems”

120.060 DESIGN RECOMMENDATIONS

A. To be developed

B. The network topology to be recommended should be a hierarchical one. A hierarchical network design has three (3) layers. Each layer provides necessary functionality to the network. Some of the main functionalities are described below:

1. The Core Layer provides optimal transport and high speed switching.
2. The Distribution Layer provides area aggregation as well as policy-based connectivity.
3. The Access or Edge Layer provides workgroup/user access to the network.
4. Other Considerations:

a) To be developed

130.000 CONTROL REQUIREMENTS

130.010 INTEGRATION REQUIREMENTS

A. To be developed

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. General

1. Refer to Division W, Section W31 “Common Clauses for IT & Security Systems”.

B. Related Sections

1. To be developed

210.000 RELATED PRODUCTS

210.010 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

PART 3 PRODUCTS AND WORKMANSHIP

300.000 PRODUCTS

300.010 MANUFACTURERS

1. To be developed

300.020 SYSTEM REQUIREMENTS

A. To be developed

300.030 WAN SERVICES

A. To be developed

300.040 WAN DEVICES & NETWORK SECURITY

A. To be developed

300.050 CONVERGED NETWORK COMMUNICATIONS

A. To be developed

300.060 CONVERGED NETWORK COMMUNICATIONS FUNCTIONALITY

A. IP Addressing
    1. To be developed
B. IP Multicasts
    1. To be developed
C. Virtual LAN (VLANS)
    1. To be developed
D. IP Virtual Private Networks (IP VPN's)
    1. To be developed
E. IP Routing Protocol (OSPF)
    1. To be developed
F. Service Delivery
    1. To be developed

300.070 CONVERGED NETWORK MANAGEMENT

A. To be developed

300.080 VOIP SYSTEM MANAGEMENT

A. To be developed

300.090 WIRELESS LAN SYSTEM MANAGEMENT

A. To be developed

300.100 CONVERGED NETWORK SWITCHES

A. Device Hierarchy
    1. To be developed
B. Device Functionality
    1. To be developed
C. Device Types
    1. To be developed
D. Device Inter-Connectivity – "Campus Network"
    1. To be developed
E. System Configurations
    1. To be developed

310.000 QUALITY MANAGEMENT

310.010 PRODUCTS AND WORK BY OTHERS / COORDINATION

A. To be developed

310.020 CONFIDENTIALITY

A. Refer to Division W, Section "Common Clauses for IT & Security Systems".

310.030 QUALITY ASSURANCE

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

310.040 DELIVERY, STORAGE AND HANDLING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

310.050 WARRANTY

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

310.060 COMMISSIONING

A. To be developed

310.070 MAINTENANCE AND SUPPORT DURING WARRANTY PERIOD

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

310.080 SPARE PARTS AND EXTRA MATERIAL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

320.000 SUBMITTALS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

330.000 EXECUTION

330.010 INSTALLATION

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

330.020 FACTORY ACCEPTANCE TESTS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

330.030 FIELD QUALITY CONTROL

A. To be developed

330.040 DEMONSTRATION AND TRAINING

A. To be developed

W31G - DATA COMMUNICATIONS FOR DATA CENTER

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. Section Includes:

1. Data Communications for "Data Center" equipment and software required to implement a fully operational data network:

a) Spine Equipment: Unified fabric spine layer to interconnect leaf layer switches

1) To be developed

b) Leaf Equipment: Unified fabric aggregate layer to aggregate and route traffic using:

1) To be developed

c) Distribution (Border node) Equipment: Unified fabric aggregate layer to aggregate and route traffic using:

1) To be developed

d) Out of Band and Field Devices Network Equipment: this Layer shall provide alternative means of connectivity to manage devices. Switches of this layer shall consolidate all site building Switches and field equipment within the Data Center.

e) Routers: To connect the LAN to external services and Wide-Area Network (WAN)

f) Firewalls:

1) To be developed

g) Intrusion Detection: To monitor and alert on illegal access and sabotage attempts to the networks.

h) Intrusion Prevention: To monitor and thwart illegal access and sabotage attempts to the networks before they gain access to the network.

i) Network Management: To be developed

2. To be developed

100.020 PERFORMANCE REQUIREMENTS

A. Network Redundancy, Reliability and Availability

1. To be developed

B. Network Performance and Quality Of Service

1. To be developed

C. Network Security

1. To be developed

D. Network Scalability

1. To be developed

E. Equipment Connection

1. To be developed

F. To be developed

G. Software Requirements

1. To be developed

H. Design Considerations

1. To be developed

I. System Expansion Capacity

1. To be developed

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

110.020 PROJECT/SITE CONDITIONS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

110.030 DEFINITIONS AND ABBREVIATIONS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Definitions

1. “OFE”: shall refer to “Owner Furnished Equipment”, which will be provided by the Owner/Employer. The Contractor shall be responsible for removing this equipment from the Owner’s premises and re-installing and integrating this equipment in good working order where required and detailed in these Specifications.
2. "Turnkey System": a complete system of hardware and software delivered to the Employer ready-to-run.
3. PUE: Power Usage Effectiveness is a metric used to determine the energy efficiency of a Servers Room. PUE is determined by dividing the amount of power entering a Servers Room by the power used to run the computer infrastructure within it.

C. Abbreviations

1. Unicast RPF: Unicast Reverse Path Forwarding.
2. BYOD: Bring Your Own Device.
3. SDN: Software Defined Network.

120.000 SYSTEM DESCRIPTION

120.010 SCOPE OF WORK

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

120.020 SYSTEM DESCRIPTION

A. Overview of Current Environment and Requirements

B. General Features

1. The Data Network active infrastructure shall be used to provide:

a) data connection of the systems/users plugged in Data Hall within Project premises.
b) The Data Hall shall be treated as an independent network meeting all the requirements of these Specifications and is to be managed independently.
c) data communications between these systems/users and the associated applications servers.
d) data connection of these systems/users to the external network (World Wide Web WWW).
e) secure data communications.

2. The Data Network shall provide redundancy at designated levels thus eliminating the presence of any single point of failure at these designated levels.
3. Coordinate the features of material and equipment so they form an integrated system. Match components and interconnections for optimum future performance.

4. The software licensing shall be for the entire network with no limitation on the number of workstations or standard end-users. In addition, the duration of licenses shall be coordinated with the client early on in the project.
5. Comply with Division W, Section "Common Clauses for IT & Security Systems"

C. To be developed

120.030 SYSTEM ARCHITECTURE

A. The system architecture shall support multi-manufacturer interoperability with other manufacturer's products and across any QoS infrastructure.

B. Each network shall be a multi-layer, fault tolerant, TCP/IP network. The LAN hierarchy shall be based on a Spine and Leaf Architecture in the Server Room/Data Hall.

C. Unified fabric switches shall be utilized in the Server Room/Data Hall to connect servers, Fiber Channel and Fiber Channel over Ethernet over common links.

D. The Data Network active infrastructure shall be highly scalable, growing from a small amount of users, up to the ultimate designed expansion capability to meet the requirements of future operational growth (in terms of number of ports and offered services) - at project completion. Although implemented mainly for voice and data communications, the infrastructure shall be capable of multiple means of real time communication (voice, video, instant messaging, collaboration, etc.). The infrastructure shall provide high availability, redundancy, and contingency. The infrastructure shall be able to integrate with many other devices and applications, from existing voice infrastructure to new endpoints and applications.

E. The system architecture shall provide bandwidth management and call admission control to guarantee at all times that the network and LAN/WAN links are not oversubscribed.

F. To be developed

120.040 TECHNICAL STUDY

A. Preliminary study

1. To be developed

B. Final study

1. To be developed

120.050 GENERAL HARDWARE REQUIREMENTS

A. To be developed

B. Refer to Division W, Section "Common Clauses for IT & Security Systems"

120.060 GENERAL SOFTWARE REQUIREMENTS

A. Refer to Division W, Section "Common Clauses for IT & Security Systems"

B. To be developed

120.070 DESIGN RECOMMENDATIONS

A. To be developed

130.000 CONTROL REQUIREMENTS

130.010 INTEGRATION REQUIREMENTS

A. To be developed

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. General

1. Refer to Division W, Section W31 “Common Clauses for IT & Security Systems”.

B. Related Sections

1. To be developed

210.000 RELATED PRODUCTS

210.010 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

PART 3 PRODUCTS AND WORKMANSHIP

300.000 PRODUCTS

300.010 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but not limited to:

1. To be developed

300.020 SYSTEM REQUIREMENTS

A. To be developed

300.030 WAN SERVICES

A. To be developed

300.040 WAN DEVICES & NETWORK SECURITY

A. To be developed

300.050 CONVERGED NETWORK COMMUNICATIONS

A. To be developed

300.060 CONVERGED NETWORK COMMUNICATIONS FUNCTIONALITY

A. IP Addressing

1. To be developed

B. IP Multicasts

1. To be developed

C. Virtual LAN (VLANS)

1. To be developed

D. IP Virtual Private Networks (IP VPN’s)

1. To be developed

E. IP Routing Protocol (OSPF)

1. To be developed

F. Service Delivery

1. To be developed

G. Power Over Ethernet (POE)

1. To be developed

300.070 CONVERGED NETWORK MANAGEMENT

A. To be developed

300.080 VOIP SYSTEM MANAGEMENT

A. To be developed

300.090 WIRELESS LAN SYSTEM MANAGEMENT

A. To be developed

300.100 CONVERGED NETWORK SWITCHES

A. Device Hierarchy

1. To be developed

B. Device Functionality

1. To be developed

C. Device Types

1. To be developed

D. Device Inter-Connectivity – "Data Center Network"

1. To be developed

E. System Configurations

1. To be developed

310.000 QUALITY MANAGEMENT

310.010 PRODUCTS AND WORK BY OTHERS / COORDINATION

A. To be developed

310.020 CONFIDENTIALITY

A. Refer to Division W, Section "Common Clauses for IT & Security Systems".

310.030 QUALITY ASSURANCE

A. Refer to Division W, Section "Common Clauses for IT & Security Systems".

310.040 DELIVERY, STORAGE AND HANDLING

A. Refer to Division W, Section "Common Clauses for IT & Security Systems".

310.050 WARRANTY

A. Refer to Division W, Section "Common Clauses for IT & Security Systems".

310.060 COMMISSIONING

A. To be developed

310.070 MAINTENANCE AND SUPPORT DURING WARRANTY PERIOD

A. Refer to Division W, Section "Common Clauses for IT & Security Systems".

310.080 SPARE PARTS AND EXTRA MATERIAL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

320.000 SUBMITTALS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

330.000 EXECUTION

330.010 INSTALLATION

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

330.020 FACTORY ACCEPTANCE TESTS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

330.030 FIELD QUALITY CONTROL

A. To be developed

330.040 DEMONSTRATION AND TRAINING

A. To be developed

W40A - ACCESS CONTROL

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. Section Includes state-of-the-art, electronic Access Control system that enables access control, monitoring and protection of all pertinent areas of the Project facilities, consisting of:

1. Security access central-control station.
2. One or more security access networked workstations.
3. Security access operating system and application software.
4. Security access controllers connected to high-speed electronic-data transmission network.

B. Access Control System shall interface with the Fire Alarm System and other Security and Building Services Systems. These interfaces shall be hardwired where required by code.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Regulations and Standards: All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. IEC Standards

a) IEC 60839-5-1: Alarm and electronic security systems - Part 5-1: Alarm transmission systems - General requirements
b) IEC 60839-5-2: Alarm and electronic security systems - Part 5-2: Alarm transmission systems - Requirements for supervised premises transceiver (SPT)
c) IEC 60839-5-3: Alarm and electronic security systems - Part 5-3: Alarm transmission systems - Requirements for receiving centre transceiver (RCT)
d) IEC 60839-11-1: Alarm and electronic security systems - Part 11-1: Electronic access control systems - System and components requirements
e) IEC 60839-11-2: Alarm and electronic security systems - Part 11-2: Electronic access control systems - Application guidelines

2. EN Standards

a) EN 50130-4: Alarm systems - Part 4: Electromagnetic compatibility - Product family standard: Immunity requirements for components of fire, intruder, hold up, CCTV, access control and social alarm systems

C. Identification Cards shall conform to the following standards:

1. International Organization for Standardization /International Electro-technical Commission (ISO/IEC)

a) ISO/IEC 7810: Identification Cards - Physical Characteristics
b) ISO/IEC 7811-1: Identification Cards - Recording Technique Part 1: Embossing
c) ISO/IEC 7811-2: Identification Cards - Recording Technique Part 2: Magnetic Stripe - Low Coercivity
d) ISO/IEC 7811-6: Identification Cards - Recording Technique Part 6: Magnetic Stripe - High Coercivity
e) ISO/IEC 7811-7: Identification Cards - Recording Technique Part 7: Magnetic Stripe - High Coercivity, High Density
f) ISO/IEC 7816: (Parts 1 through 15): Identification Cards - Integrated Circuit Cards
g) ISO/IEC 14443: (Parts 1 through 4): Identification cards - Contactless integrated circuit cards - Proximity cards.

h) ISO/IEC 15693: (Parts 1 through 3): Identification cards - Contactless integrated circuit cards - Vicinity cards.

D. American National Standards Institute / Telecommunications Industry Association / Electronic Industries Alliance (ANSI/TIA/EIA)

1. TIA-232-F: Interface between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange
2. TIA-485-A: Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems

E. The system functions in public areas such as elevators, lobbies and parking areas shall comply with the Accessibility Guidelines by Authorities Having Jurisdiction.

110.020 PROJECT/SITE CONDITIONS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

110.030 DEFINITIONS AND ABBREVIATIONS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Definitions

1. To be developed

120.000 SYSTEM DESCRIPTION

120.010 SCOPE OF WORK

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Other Clarifications Related to The Scope of Work

C. The Access Control shall utilize the project Security Network.

D. To be developed

120.020 FUNCTIONAL DESCRIPTION OF SYSTEM

A. Security Access System: Workstation-based central station, one or more networked Workstation-based workstations, and field-installed controllers, connected by a high-speed electronic-data transmission network.

B. System Software:

1. To be developed

C. To be developed

D. Network(s) connecting workstations and controllers shall consist of one or more of the following:

1. To be developed

130.000 CONTROL REQUIREMENTS

130.010 INTEGRATION REQUIREMENTS

A. To be developed

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. General

1. Refer to Division W, Section W31 “Common Clauses for IT & Security Systems”.

B. Related Sections

1. To be developed

210.000 RELATED PRODUCTS

210.010 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

210.020 SIGNAL TRANSMISSION COMPONENTS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed.

210.030 CONDUITS, TRUNKING, ENCLOSURES AND FITTINGS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

PART 3 PRODUCTS AND WORKMANSHIP

300.000 PRODUCTS

300.010 MANUFACTURERS

A. Available Manufacturers of Access Control System: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. To be developed

300.020 OPERATION

A. Security access system shall use a single database for access-control and credential-creation functions.

B. Distributed Processing: A fully distributed processing system.

1. To be developed

C. Number of Locations:

1. To be developed

D. Data Capacity:

1. To be developed

E. Location Capacity:

1. To be developed

F. System Network Requirements:

1. To be developed

G. To be developed

300.030 APPLICATION SOFTWARE

A. To be developed

300.040 SYSTEM DATABASE

A. To be developed

300.050 CENTRAL-STATION HARDWARE

A. Central-Station Computer Workstations

1. To be developed

B. To be developed

300.060 FIXED MAP DISPLAY

A. To be developed

300.070 CONTROLLERS

A. To be developed

300.080 SECONDARY ALARM ANNUNCIATOR

A. To be developed

300.090 CARD READERS, CREDENTIAL CARDS, PANIC ALARM AND KEYPADS

A. To be developed

300.100 BIOMETRIC IDENTITY-VERIFICATION EQUIPMENT

A. To be developed

300.110 ENROLLMENT CENTER

A. To be developed

300.120 FIELD-PROCESSING SOFTWARE

A. To be developed

300.130 FIELD-PROCESSING HARDWARE

A. To be developed

300.140 TIA-232-F ASCII INTERFACE SPECIFICATIONS

A. To be developed

300.150 FLOOR-SELECT ELEVATOR CONTROL

A. To be developed

300.160 REAL-TIME GUARD TOUR

A. To be developed

300.170 VIDEO AND CAMERA CONTROL

A. To be developed

300.180 CAR PLATE NUMBER IDENTIFICATION SYSTEM

A. To be developed

300.190 ACCESS HARDWARE SPECIFICATIONS

A. To be developed

300.200 SURGE AND TAMPER PROTECTION

A. To be developed

300.210 PUSH-BUTTON SWITCHES

A. To be developed

300.220 DOOR AND GATE HARDWARE INTERFACE

A. To be developed

300.230 PROPOSED SOLUTION

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Data Transmission:

1. The data transmission rate between the workstations and the servers shall be bi-directional using TCP/IP VLAN Network.
2. Coordinate IP addressing, Ethernet switch port counts and assignments, long-term storage requirements and bandwidth utilization with the Contractor providing and configuring the dedicated security VLAN.

300.240 NETWORK EQUIPMENT

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

300.250 TRANSFORMERS

A. Control transformers listed for security access-control systems: shall not be shared with any other system.

310.000 QUALITY MANAGEMENT

310.010 PRODUCTS AND WORK BY OTHERS / COORDINATION

A. To be developed

310.020 MISCELLANEOUS QUALITY MANAGEMENT TOPICS

A. For the following quality management topics, refer to Division W, Section “Common Clauses for IT & Security Systems”:

1. CONFIDENTIALITY
2. QUALITY ASSURANCE
3. DELIVERY, STORAGE AND HANDLING
4. WARRANTY
5. COMMISSIONING
6. MAINTENANCE AND SUPPORT DURING WARRANTY PERIOD

310.030 SPARE PARTS AND EXTRA MATERIAL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

320.000 SUBMITTALS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

330.000 EXECUTION

330.010 INSTALLATION

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

330.020 FACTORY ACCEPTANCE TESTS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

330.030 FIELD QUALITY CONTROL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

330.040 OCCUPANCY ADJUSTMENTS

A. To be developed

330.050 PROTECTION

A. To be developed

330.060 DEMONSTRATION AND TRAINING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

W40B - PARKING CONTROL EQUIPMENT

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. Section Includes:

1. Automatic barrier gates.
2. Vehicle detectors.
3. Traffic controllers.
4. Entry terminals.
5. Exit terminals.
6. Pay stations.
7. Fee computers.
8. Miscellaneous parking control equipment.
9. Parking facility management software.
10. Access control units.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. The publications listed below form a part of this specification. The publications are referred to in the text by basic designation only.

C. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean reference to the latest printed edition of each.

D. Conflicts

1. Should an instance occur in this Specification or on the Drawings in which material or construction methods called for is less than minimum requirement of the reference standards, immediately inform the Engineer in writing. Consequent to Engineer's approval, supply the materials and perform the work as though called for to minimum code standards.

E. Referenced Standards

1. International British (BS), European (EN) and IEC Standards which are in relationship with each other, tackle the same topic and carry the same number, can be used interchangeably in this specification since they are assumed to have the same intent and target the same level of quality and safety. For example: BS EN 60529 and IEC 60529. This shall be applicable to all subjects except for life safety related materials and systems (such as the Fire Alarm System) whereby BS / BS EN shall remain mandatory.

F. Compliance with Local Requirements: Comply with applicable building code, local ordinances and regulations, and requirements of authorities having jurisdiction.

G. Codes and Standards: All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the references:

1. The European Machinery Directive (2006/42/EC) regarding health and safety requirements and shall carry CE mark and be accompanied with a declaration of conformity. All relevant standards are to be mentioned – as appropriate.
2. EN 13241-1, Industrial, commercial and garage doors and gates — Product standard — Part 1: Products without fire resistance or smoke control characteristics
3. EN 12453, Industrial, commercial and garage doors and gates. Safety in use of power operated doors. Requirements.

4. EN 12445, Industrial, commercial and garage doors and gates. Safety in use of power operated doors. Test methods.
5. EN 12635, Industrial, commercial and garage doors and gates. Installation and use.
6. EN 12978, Industrial, commercial and garage doors and gates. Safety devices for power operated doors and gates. Requirements and test methods.
7. EN 12604, Industrial, commercial and garage doors and gates. Mechanical aspects. Requirements.
8. EN 12605, Industrial, commercial and garage doors and gates. Mechanical aspects. Test Methods.
9. EN 13849-1, Safety of machinery. Safety-related parts of control systems. General principles for design.
10. EN 60204-1, Safety of machinery. Electrical equipment of machines.

H. General requirements: All electrical works shall comply with the local Electricity Regulations.

1. To be developed

I. Local regulations and standards, where enforced and relevant, are to have precedence over the Standards.

110.020 PROJECT/SITE CONDITIONS

A. Environmental Conditions: Equipment shall be capable of withstanding the project environmental conditions specified under Division V, Section “Basic Electrical Materials and Methods” encountered at the installed location without mechanical or electrical damage or degradation of operating capability as applicable to.

1. Interior, Controlled Environments.
2. Interior, Uncontrolled Environments.
3. Exterior Environments.

B. Thermal Movements: To be developed

C. Waterproof Equipment: Listed and labeled for duty outdoors or in damp locations, with a minimum Ingress Protection rating of IP65.

D. Barriers and gates shall be designed to withstand adverse local environmental conditions.

1. To be developed

E. Expansion Capability: To be developed

F. Power Supply: To be developed

110.030 DEFINITIONS AND ABBREVIATIONS

A. Not Applicable.

120.000 SYSTEM DESCRIPTION

120.010 SCOPE OF WORK

A. The Contractor shall provide, based on these specifications and design drawings, the final design and construction documents and all equipment, software, material, labor and services required to construct and install the Parking Control Equipment including, but not limited to:

1. To be developed

B. Parking Control Equipment shall include all wiring, control cabling, conduit, boxes, weather- proof enclosures, contactors and accessories and ancillary work, whether described in the Specification or not, required for a complete and fully operational system.

C. The Parking Control Equipment shall interface with the Access Control System, Intercom System and other Building Services Systems. Monitoring and Control information shall be output to the Building Management System (BMS).

1. To be developed

D. To be developed

120.020 SYSTEM DESCRIPTION

A. Parking Control System: For the following types of parking management:

1. To be developed

130.000 CONTROL REQUIREMENTS

130.010 INTEGRATION REQUIREMENTS

A. The Parking Control Equipment shall be integrated and interfaced to the following systems:

1. To be developed

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. General

1. To be developed

210.000 RELATED PRODUCTS

210.010 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. To be developed

210.020 SIGNAL TRANSMISSION COMPONENTS

A. General Cable Requirements: Size and type as recommended in writing by system manufacturer unless otherwise indicated.

B. To be developed

210.030 CONDUITS, TRUNKING, ENCLOSURES AND FITTINGS

A. To be developed

PART 3 PRODUCTS AND WORKMANSHIP

300.000 PRODUCTS

300.010 MANUFACTURERS

A. Available Manufacturers of Parking Control Equipment: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. To be developed

300.020 AUTOMATIC BARRIER GATES

A. General: Provide parking control device consisting of operator and controller housed in a weather-tight, tamper-resistant cabinet enclosure with gate arm. Device shall be activated by a signal from access or revenue control device.

B. Standards: comply with EN 12453, EN 12445, EN 12635, EN 12978 and EN 12604. .

C. To be developed

300.030 VEHICLE DETECTORS

A. General: Provide detection devices that sense presence or transit of vehicles and emit signals activating gate-arm operators.

B. Vehicle Loop Detector System: Self-tuning electronic presence detector with adjustable detection patterns, adjustable sensitivity and frequency settings, and panel indicator light.

   1. To be developed

C. Active Infrared Vehicle Detector or Camera Analytics

   1. To be developed

300.040 TRAFFIC CONTROLLERS

A. General: Provide directional enforcement system that allows passage of vehicle in only one direction.

B. Penetrating Type: System consisting of multiple raised teeth that allow vehicular traffic in one direction and that puncture tires of vehicular traffic in the other direction. Fabricate system from steel plate contained in welded steel frame.

   1. To be developed

C. Non-penetrating Type: System consisting of steel curb that allows traffic in only one direction. Fabricate system from steel plate contained in welded steel frame.

   1. To be developed

D. Road Blockers - Bollards

   1. To be developed

300.050 ENTRY TERMINALS

A. Use manufacturers' catalogs or product data to insert series, type, model, and designations of other characteristics.

B. To be developed

300.060 EXIT TERMINALS

A. General: Provide exit terminals with controllers, components housed in cabinet enclosures.

A. To be developed

300.070 PAY STATIONS

A. General: Provide self-contained, cashiering pay stations designed for self-service operation; with mechanisms, components, controllers, and fee computers housed in a combined enclosure.

B. To be developed.

300.080 FEE COMPUTERS

A. General: Provide modular PC-based system. Register permanent record of each transaction in computer's memory.

B. To be developed

300.090 MISCELLANEOUS PARKING CONTROL EQUIPMENT

A. To be developed

B. Traffic Lights

   1. To be developed.

C. Parking Guidance System

1. To be developed.

300.100 PARKING FACILITY MANAGEMENT SOFTWARE

A. General: Manufacturer's standard software that is compatible with security-access control system and that provides automatic facility monitoring, supervision, and remote control of parking control equipment from one or more locations.

B. To be developed

300.110 ACCESS CONTROL UNITS

A. General: Provide access control unit that activates barrier gates.

B. Unit Housing: To be developed.

C. Card Reader Controlled Unit: Functions only when authorized card is presented.

1. To be developed

D. Digital Keypad Controlled Unit: Functions only when authorized code is entered on

1. To be developed

E. Radio-Controlled System: Digital access control system consisting of code-compatible universal coaxial receiver

1. To be developed

300.120 ANCHORAGES

A. Anchor Bolts:

1. To be developed

310.000 QUALITY MANAGEMENT

310.010 PRODUCTS AND WORK BY OTHERS / COORDINATION

A. To be provided.

B. Parking Control Equipment shall be fully coordinated with the traffic flow requirements, the Security and Access Control system, the Intercom System and License Plate Recognition (LPR) System (forming part of Access Control System) of the Project

310.020 CONFIDENTIALITY

A. The Contractor shall respect and protect the privacy and confidentiality of the Employer, his employees, processes, products, and intellectual property to the extent necessary, consistent with the legal responsibilities of the Employer policies.

B. Contractor shall sign a non-disclosure agreement and abide by the requirements to keep confidential all information concerning bid documents and this Project.

310.030 QUALITY ASSURANCE

A. To be developed

310.040 DELIVERY, STORAGE AND HANDLING

A. Comply with Project “Preliminaries and General Requirements”.

310.050 WARRANTY AND MAINTENANCE

A. To be developed

310.060 SPARE PARTS AND EXTRA MATERIAL

A. To be developed

320.000 SUBMITTALS

A. The Contractor shall not perform any part of the work requiring submittal and review of shop drawings, product data or samples until Engineer / Employer has approved the respective submittal. Such work shall be in accordance with approved submittals:

1. Product data: For each type of product.
2. Shop Drawings.
3. Wiring diagrams to show typical wiring schematics.
4. System Operation: Include system architecture and performance requirements.

B. Submittals shall comply with Project “Preliminaries and General Requirements”.

A. To be developed

B. Testing Plan: To be developed

C. Test Equipment

1. To be developed

D. Contractor shall submit the required Field Test Reports in the format and media specified, upon completion of testing the installed system.

1. To be developed

E. Product data: For each type of product.

1. To be developed

F. Shop Drawings

1. To be developed

G. Qualifications

1. To be developed

H. Closeout Submittals (Record Documents):

1. To be developed

I. Operations and Maintenance Manuals to include:

1. To be developed

330.000 EXECUTION

330.010 EXAMINATION

A. To be developed

330.020 PREPARATION

A. To be developed

330.030 INSTALLATION

A. General: Install parking control equipment as required for a complete and integrated installation.

B. To be developed

330.040 FACTORY ACCEPTANCE TESTS

A. The Factory Acceptance Tests shall be carried out in a hardware and software environment, which simulates the final configuration of the system.

B. To be developed

330.050 FIELD QUALITY CONTROL

A. To be developed

330.060 ADJUSTING

A. Adjust parking control equipment to function smoothly and lubricate as recommended by manufacturer.

B. Confirm that locks engage accurately and securely without forcing or binding.

C. To be developed

330.070 PROTECTION

A. To be developed

330.080 DEMONSTRATION AND TRAINING

A. Train Employer's maintenance personnel to adjust, operate, and maintain parking control equipment. Refer to Refer to Project “Preliminaries and General Requirements”.

B. To be developed

W42A - VIDEO SURVEILLANCE

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. Section includes an IP Video Surveillance System consisting of but not limited to:

1. IP CCTV Cameras,
2. Software,
3. Servers and Workstations.
4. Data Storage System.
5. Ancillary equipment.

B. This system shall provide for:

1. The transport of video signals to the video recorders via the Project Data Communications Network.
2. The display of live camera video.
3. The archiving of all camera video onto a long-term storage facility located at the Security Control Room**.**

C. The Video Surveillance System (VSS) shall interface with Access Control System, Perimeter Security Systems, Intrusion Detection Systems, the Fire Alarm System and other Building Services Systems.

100.020 GENERAL FEATURES

A. The IP surveillance system shall provide digital video capture, transportation, management, recording, live viewing, playback, and storage for the video surveillance system.

B. To be developed

C. 25% spare capacity shall be required at all levels of the system.

D. The software licensing shall be provided for the entire network with no limitation on the number of workstations or standard end-users.

E. The Video Surveillance System shall be used by agents mainly for operation management and for access control of staff and passengers, inside the Project.

F. The Video Surveillance system shall be used for:

1. Operation purposes at the Project.
2. The monitoring of all vital areas in the Project.
3. Surveillance to help enforce safety and security.
4. General surveillance general traffic areas.
5. Facial Recognition.

G. The functions of the CCTV shall consist of:

1. Facilitating the coordination of the operations.
2. Supplying staff with video information.
3. Managing the flow of passengers and access for maintenance staff.
4. Monitoring of gates for the access control system and Security Audio Communication system (Intercom).
5. Monitoring of zones for Fire Alarm System at the Fire Command Center/Main Fire Station (FCC/MFS).
6. Recording and storage images.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Regulations and Standards: All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

C. IEC Standards

1. To be developed.

D. EN Standards

1. To be developed

E. Comply with the latest issues of the ONVIF Specifications.

F. Control Room Design:

1. To be developed

110.020 PROJECT/SITE CONDITIONS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Environmental Conditions: To be developed

110.030 DEFINITIONS AND ABBREVIATIONS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Definitions

1. “OFE”: shall refer to “Owner Furnished Equipment”, which will be provided by the Owner/Employer. The Contractor shall be responsible for removing this equipment from the Owner’s premises, and re-installing and integrating this equipment in good working order where required and detailed in these Specifications.
2. "Turnkey System": a complete system of hardware and software delivered to the customer ready-to-run.
3. ONVIF™: Open Network Video Interface Forum , an open standard developed to allow the management of IP cameras and other network video devices via a unified, open platform standard. ONVIF is an organization started in 2008 by Axis Communications, Bosch Security and Sony. The aim of the ONVIF™ standards is to achieve interoperability between IP cameras and other network video devices regardless of manufacturer.
4. Frame rate, is the measurement of how quickly a camera produces unique, consecutive images called frames. Frame rate is most often expressed in frames per second (fps). Depending on how a given scene is captured in terms of motion, typical frame rates are 4, 12 and 25 fps for PAL-based systems and 5, 15 and 30 fps for NTSC-based systems respectively.
5. Camera Functionalities: Defined functional purpose of a camera – as per IEC 62676-4:

    a) Inspect: to enable the operator to obtain information from objects.
    b) Identify: to enable identification of an individual beyond reasonable doubt.
    c) Recognise: to enable the Operator to obtain recognition of an individual.
    d) Observe: enabling characteristic details of an individual, such as distinctive clothing to be seen, whilst allowing a view of activity surrounding an incident.
    e) Detect: to enable the Operator to reliably and easily determine whether or not any target, such as a person, is present.
    f) Monitor: to enable viewing of the number, direction and speed of movement of people across a wide area, providing their presence is known to the Operator.

6. NETD: Noise Equivalent Temperature Difference. It is a measure for how well a thermal imaging detector is able to distinguish between very small differences in thermal radiation in the image. NETD is expressed in milli-Kelvin (mK). It specifies the smallest temperature difference that can be detected and.is also sometimes referred to as “Thermal Contrast”.
7. To be developed

C. Abbreviations

1. To be developed

120.000 SYSTEM DESCRIPTION

120.010 SCOPE OF WORK

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

120.020 SYSTEM DESCRIPTION

A. The Video Surveillance System (VSS) shall provide digital video capture, transportation, management, recording, live viewing, playback, and storage of the video. The VSS shall be based on capturing and processing Ethernet transmission of video signals from cameras. The entire VSS system shall be capable of being partitioned and allow sharing of selected video signals between Security personnel and other operational personnel as required.

B. The Video Surveillance IP/Ethernet based system shall consist of video management and archiving software, Power over Ethernet (PoE) IP fixed cameras and IP cameras with pan, tilt zoom (PTZ) features, camera housings and mounting hardware, and power supplies required to form a fully functional and operational network based virtual matrix surveillance system and network based digital video recording system.

C. The system shall operate on a digital IP/Ethernet network, the Security Network of the project. The Contractor shall coordinate for the provision of network switches as part of this Project as required to accommodate the VSS.

D. The system shall have the capability to allow live video monitoring via web browsers or wireless devices. Access shall be restricted by two-factor authentication and encryption as directed by Employer. The cameras and video accessible via web browser or wireless devices shall be limited based upon user and shall be configurable by the System Administrator to limit access by person and by device or by access method.

E. The system shall include a combination of fixed and pan tilt zoom cameras, video recording and archiving servers The camera management and recording servers shall be connected to the network.

F. The VSS shall include an Intelligent Video Analysis System (IVAS). The IVAS shall apply automatic, persistent artificial intelligence to video signals in an effort to improve the efficiency of Operators by directing them immediately to events that need attention and provide them an easy way to determine the appropriate action.

G. The Contractor shall provide data cables copper or fiber optic between the IP Surveillance System and the horizontal Floor Telecom Room FTR.

H. All Indoor cameras shall be wired through Category 6A cabling to the nearest FTR.

I. All Outdoor cameras attached to building boundary and located within the Copper cabling range, shall be wired through Category 6Acabling to the nearest FTR.

J. All Outdoor Cameras that are not within any FTR copper cabling range shall be wired to the Main Telecom Room and FTR rooms/closets using fiber optic cables with proper media converters for the purpose. All wiring, Patching and needed active and passive components shall form part of the Contract.

K. The Contractor shall provide for the necessary IP cameras, data network switches, local workstations, patch panels, fiber optic cables, copper cables, accessories and ancillary, etc. for the complete operation and full integration of the above.

L. The Contractor shall fully coordinate with the Employer for the exact location and positioning of the different equipment and materials.

M. To be developed

120.030 SYSTEM ARCHITECTURE AND COMPONENTS

A. The VSS shall consist of IP compatible cameras, both fixed and PTZ, connections to the LAN via Cat 6Acabling or fiber, LAN switches, Video and Archiving Servers, system workstations, and all associated software and hardware required for a complete and operational system.

B. Provide all software licenses required for the specified monitoring and control.

C. To be developed

130.000 CONTROL REQUIREMENTS

130.010 INTEGRATION REQUIREMENTS

A. The IP Surveillance System shall be integrated and interfaced to the following systems:

1. To be developed

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. General

1. Refer to Division W, Section W31 “Common Clauses for IT & Security Systems”.

B. Related Sections

1. To be developed

210.000 RELATED PRODUCTS

210.010 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

210.020 SIGNAL TRANSMISSION COMPONENTS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

210.030 CONDUITS, TRUNKING, ENCLOSURES AND FITTINGS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

PART 3 PRODUCTS AND WORKMANSHIP

300.000 PRODUCTS

300.010 MANUFACTURERS

A. To be developed

300.020 COMPONENTS

A. General:

1. To be developed

B. Color

1. To be developed

C. Cameras

1. To be developed

D. Lenses
    1. To be developed
E. PTZ Camera Power Supply
    1. To be developed
F. Media Converters
    1. To be developed
G. Security Lighting
    1. To be developed
H. CCTV Columns
    1. To be developed

300.030 VSS PROCESSING SERVER

300.040 APPLICATION/CONTROL SERVER

300.050 VSS SOFTWARE REQUIREMENTS

300.060 REMOTE WEB ACCESS

300.070 VIRTUAL MATRIX APPLICATION SOFTWARE

300.080 VIRTUAL MATRIX

300.090 WORKSTATION REQUIREMENTS

300.100 VIDEO SERVER REQUIREMENTS

300.110 INTELLIGENT VIDEO ANALYSIS SYSTEM (IVAS)

300.120 FACIAL RECOGNITION

300.130 STORAGE CONSIDERATIONS

300.140 LAN INFRASTRUCTURE SYSTEM REQUIREMENTS

300.150 ALARMS AND EVENTS

300.160 PROPOSED SOLUTION

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.
B. To be developed

300.170 NETWORK EQUIPMENT

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.
A. To be developed

310.000 QUALITY MANAGEMENT

310.010 PRODUCTS AND WORK BY OTHERS / COORDINATION

A. To be developed

310.020 QUALITY ASSURANCE

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. All system components such as cameras, storage systems, etc. shall be ONVIF compliant.

310.030 MISCELLANEOUS QUALITY MANAGEMENT TOPICS

A. For the following quality management topics, refer to Division W, Section "Common Clauses for IT & Security Systems":

1. CONFIDENTIALITY
2. DELIVERY, STORAGE AND HANDLING
3. WARRANTY
4. COMMISSIONING
5. MAINTENANCE AND SUPPORT DURING WARRANTY PERIOD

310.040 SPARE PARTS AND EXTRA MATERIAL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

320.000 SUBMITTALS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

330.000 EXECUTION

330.010 INSTALLATION

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Additional Installation Requirements: To be developed

330.020 FACTORY ACCEPTANCE TESTS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

330.030 FIELD QUALITY CONTROL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

330.040 CLEANING

A. To be developed

330.050 OCCUPANCY ADJUSTMENTS

A. To be developed

330.060 DEMONSTRATION AND TRAINING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

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W43 – SECURITY SCREENING SYSTEMS (SSS)

1.1 RELATED DOCUMENTS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems” for requirements.

1.2 SUMMARY

A. Section includes state-of-the-art, electronic Security Screening Systems (SSS) requirements for the Project.

B. The SSS shall screen all passengers, staff, passenger baggage and goods entering the airport as well as Customs screening of all baggage and goods arriving at the airport from other countries.

1.3 REFERENCES

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Definitions

1. Baggage: Such articles, effects and other personal properties of a passenger as are necessary for wear, use, comfort or convenience in connection with his trip. Unless otherwise specified it includes both checked-in and unchecked baggage.
2. Baggage Handling System: Automated System handling hold baggage from the check-in desk to the Unit Load Device (ULD) for departing baggage and from the ULD to the reclaim carousel for arrival baggage.
3. Carry-on baggage: Baggage that the passenger carries onto an aircraft that is screened at the security screening checkpoint. By extension, for staff, carry-on belongings that staff can bring on site that is screened at security screening checkpoints.
4. Hold Baggage: Baggage that the passenger does not carry in the cabin. The Hold bag is traveling in the aircraft hold. The Hold baggage is checked-in at the departure and is reclaimed by the passenger at the arrival.
5. Hold Baggage Screening: Hold Baggage is security screened in the departure airport via the BHS, security screened at transfer airports (as required), and is Customs screened at the arrival airport.
6. Third Party: The Third Party is a company independent from the Master Systems Contractor, to be appointed at Master Systems Contractor expenses to provide Technical Certifications as necessary (structure, electrical items, emergency stop system, Health & Safety, etc.).
7. Operator: The Operator is the entity in charge to operate the Passenger Terminal Building, particularly to perform ground handling, security operation etc.
8. Security/Customs Authority: The Security/Customs Authority or appropriate Authority having legal competency to provide agreement related to Security, Customs and more generally all issues related to International or National Rules and Laws.

1.4 SYSTEM DESCRIPTION

A. Security Screening shall consist of different types of Security Screening Systems distributed at key locations throughout the Terminals and other project facilities and connected to the Project Security Network.

B. System design shall take into consideration Project requirements in terms of end users special needs, regulations, system planning, operation, changes and maintenance.

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C. The Security Screening Systems shall consist of Ethernet based, redundant, real-time host processors/servers, multiple workstations and terminals. The workstations will include supervisory workstations, On-Screen Resolution workstations, and viewing workstations for search and resolution stations. The system shall be capable of routing individual alarms or On-Screen Resolution (OSR) images to specific workstations.

D. To be developed.

1.5 SCOPE OF WORK

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To Be Developed

1.6 SUBMITTALS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B.

C. To Be Developed

1.7 QUALITY ASSURANCE

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

1.8 WARRANTY

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

1.9 PRODUCTS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

1.10 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers shall meet all specifications requirements and shall be approved by the Engineer.

1.11 GENERAL OVERVIEW

A. Four types of Check and Inspection Points types are identified, plus additional screening types:
   1. SCP Screening Checkpoint
   2. SSCP Staff Screening Checkpoint
   3. GWSCP Goods and Waste Screening Checkpoint
   4. CSCP Customs Screening Check Point

B. Screening Check Point (SCP)

C. Staff Screening Check Point (SSCP)

D. Goods and Waste Screening Check Point

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E. Customs Screening Checkpoint (CSCP)

1.12 WALK-THROUGH METAL DETECTOR

1.13 HAND-HELD METAL-DETECTOR

1.14 EXPLOSIVE TRACE DETECTION UNITS

1.15 CONVENTIONAL X-RAY SCANNERS

1.16 EXPLOSIVE DETECTION SYSTEM MACHINE

1.17 FURNITURE AND ACCESSORIES

1.18 FINISHES: CORROSION PROTECTION

1.19 DELIVERY, STORAGE, AND HANDLING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

1.20 SOFTWARE LICENSING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

1.21 INSTALLATION

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Protection and Cleaning

1. Maintain strict security during the installation of equipment and software. Rooms housing the control station, and workstations that have been powered up shall be locked and secured with an activated burglar alarm and access-control system reporting to a central station complying with UL 1610, "Central-Station Burglar-Alarm Units," during periods when a qualified operator in the employment of the CONTRACTOR is not present.
2. Repair exposed surfaces to match original finish.
3. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, which guarantee storage of control equipment is without damage or deterioration at the time of Final Acceptance.

1.22 EXAMINATION AND FIELD QUALITY CONTROL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To Be Developed

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1.23 TESTING AND COMMISSIONING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

1.24 TRAINING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

1.25 CLOSEOUT SUBMITTALS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

1.26 COMPLETION AND SYSTEM ACCEPTANCE

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

W44 – EMERGENCY ASSIST ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions, Employer's Design Standards, Procedures, Manuals and Specifications, including without limitation Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes an Emergency Assist Alarm System to be provided at disabled toilets designed for persons with restricted mobility (PRM) within the Project.

1. Remote indication shall be provided at a central control or monitoring point provided at the security office.

B. Related Sections

1. To be developed

1.3 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. Specific reference in specifications to codes, rules, regulations, standards, manufacturer's instructions, or requirements of regulatory agencies shall mean reference to the latest printed edition of each.

C. Codes and Standards: All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following reference(s):

1. BS 8300-2, Design of an accessible and inclusive built environment. Buildings. Code of practice.

D. Compliance with Local Requirements:

1. The system functions in public areas shall comply with the most current version of the Accessibility Guidelines by Authorities Having Jurisdiction.
2. Local regulations and standards, where enforced and relevant, are to have precedence over the Standards.

E. Sustainability Requirements: Comply with indicated Codes and sustainability targets and requirements specified in Division 01 Sustainability Sections:

F. Local regulations and standards, where enforced and relevant, are to have precedence over the Standards.

1.4 DEFINITIONS AND ABBREVIATIONS

A. Definitions

1. Emergency Voice/Alarm Communications System (EVACS): Dedicated manual or automatic equipment for originating and distributing voice instructions, as well as alert and evacuation signals pertaining to a fire emergency, to the occupants of a building.
2. Emergency Communication System (ECS): A system for the protection of life by indicating the existence of an emergency and communicating information necessary to facilitate an appropriate response and action, such as evacuation.

B. Abbreviations

1. EVACS: Emergency Voice/Alarm Communications System.
2. PRM: Persons with Restricted Mobility.

1.5 SCOPE OF WORK

A. The Contractor shall provide, the final design and construction documents and all equipment, software, material, labor and services required to construct and install the Emergency Assist Alarm System infrastructure including, but not limited to:

1. All design services, drawings and specifications, equipment, software, materials, labor and services, not specifically mentioned or shown, which may be necessary to complete the design and installation of the system.
2. Installation and setup of the system hardware and software as specified.
3. Coordination with the Service Providers of interfaced systems.
4. Integration of the system with other systems and in coordination with the Employer.
5. Delivery of the “Interface Control Document - ICD”.
6. Final connection of hardware to power, infrastructure termination and patch cords connecting system equipment to the data outlets and other network communication equipment.
7. Documentation: Licenses, Shop drawings, Specifications, As-built drawings, user’s manual, operation and maintenance manuals, test reports, etc.
8. Handover manufacturer’s recommended spare parts (along with current unit prices) for all major components in the system for two (2) years fault-free operation.
9. Handover manufacturer’s recommended test equipment and tools (along with current unit prices) required for system maintenance.
10. Test plan.
11. System testing and commissioning.
12. System roll-out.
13. System warranty as specified herein.
14. Training as specified herein.
15. Maintenance and support as specified herein.
16. Supply the licenses for all software, programs and modules provided for the works including those developed and modified by the Contractor. The appropriate licenses supplied by the Contractor shall enable the Employer to use, modify, and develop the software, programs and modules for the works supplied under this Contract.

1.6 PRODUCTS AND WORK BY OTHERS / COORDINATION

A. To be developed

1.7 CONFIDENTIALITY

A. The Contractor shall respect and protect the privacy and confidentiality of the Employer, his employees, processes, products, and intellectual property to the extent necessary, consistent with the legal responsibilities of the Employer policies.

B. Contractor shall sign a non-disclosure agreement and abide by the requirements to keep confidential all information concerning bid documents and this Project.

1.8 SUBMITTALS

A. The Contractor shall not perform any part of the work requiring submittal and review of shop drawings, product data or samples until Employer's Representative / Employer has approved the respective submittal. Such work shall be in accordance with approved submittals:

1. Product data: For each type of product.
2. Shop Drawings.
3. Wiring diagrams to show typical wiring schematics.
4. System Operation: Include system architecture and performance requirements.

B. Samples for initial selection:

C. Product Certificates:

D. Manufacturer's Endorsement

E. Signed Warranty: as specified.

F. Testing Plan:

G. Test Equipment

H. Contractor shall submit the required Field Test Reports in the format and media specified, upon completion of testing the installed system.

I. Product data: For each type of product.

J. Calculations:

K. Environmental Requirements.

L. Shop Drawings

M. Coordination Drawings:

N. Qualifications

O. Closeout Submittals (Record Documents):

P. Operations and Maintenance Manuals to include:\

1.9 QUALITY ASSURANCE

A. Qualifications:To be developed

B. Standard Products

1. Identical Items: All items of the same classification shall be identical. This requirement includes equipment, assemblies, parts, and components.

C. Electromagnetic Compatibility (EMC)

1. Ensure all equipment and systems are installed to provide electromagnetic compatibility within the system and with any other systems installed in the same location.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Comply with Division 01, Section “Product Requirements”.

1.11 PROJECT/SITE CONDITIONS

A. Environmental Conditions:

B. Operational Constraints: The system will run 24 hours per day, all the days of the year.

C. Unless otherwise indicated, 25% spare capacity shall be required at all levels of the system.

D. Power Supply

1.12 WARRANTY AND MAINTENANCE

A. Contractor shall provide a three years warranty for the works specified herein, including all materials, software and labor, to be free from defects in design, workmanship, and materials.

B. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

1.13 SPARE PARTS AND EXTRA MATERIAL

A. The manufacturer shall guarantee the flow and availability of the spare parts without a major design change for at least ten years’ period from date of System Acceptance by Employer.

B. Refer to Division W, Section “Common Clauses for IT & Security Systems”..

PART 2 - PRODUCTS

2.1 GENERAL EQUIPMENT AND MATERIAL REQUIREMENTS

A. The Emergency Assist Alarm system shall provide a BS 8300 - Code compliant solution suitable for stand-alone toilet alarms as well as multiple toilet alarms with central remote monitoring.

B. Each system controller shall be capable of monitoring up to 16 stand-alone toilets. The system shall be integrated into the fire alarm Emergency Voice /Alarm System (EVACS) or the BMS.

C. The controller and individual toilet controllers shall be IP based and shall communicate through the data network of the Project.

D. The system shall be supplied from power supply units which are backed up with battery supply to ensure continuous operation in the case of mains failure.

E. Visual and audible feedback shall be provided to indicate that, when the alarm has been activated, the emergency assistance call has been acknowledged and is being attended to.

F. The system shall be designed such that it is not confused visually or audibly with a fire alarm.

2.2 SYSTEM COMPONENTS

A. The system shall consist of the following components:

1. Controller
2. Ceiling Pull Cord Unit
3. Call Point
4. Reset Point / Cancel button
5. Overdoor Indicator
6. Network interface module
7. Power Supply Unit and Backup Battery.

B. System components including: pull cord units, call points, cancel buttons and overdoor indicators shall fit into single gang back boxes with approximate dimensions of 86 mm x 86 mm (Width x Height) and finish inline with the requirements of the Interior Designer.

1. Controller

    a. Controllers shall be installed in the security office, in coordination with the Employer's Representative/end user
    b. To be developed

2. Ceiling Pull Cord Unit

    a. The Pull Cord Units shall be used to activate disabled toilets alarms.
    b. To be developed

3. Call Point

    a. Emergency call points shall be used to activate emergency assist alarms.
    b. To be developed

4. Reset Point / Cancel button

a. The cancel button shall be used to reset activated emergency assist alarms.
b. To be developed

5. Overdoor Indicator (Beacon/Sounder)

a. The overdoor indicator shall be combined beacon-sounder unit similar to the "Beacon" specified in Sub-paragraph above but with an integral sounder.
b. To be developed

6. Network interface module:

a. This module shall enable remote monitoring of alarm status and muting of alarm sounders using a standard serial communications protocol.
b. To be developed

7. Power Supply Unit with an integrated battery charger and dedicated backup batteries

C. Additional Provisions

1. Panic Bar

a. A panic bar shall be located on one of the walls of the disabled toilet such that the user can press or grab to it in case of falling to the floor, to initiate a call for help.
b. To be developed

2.3 INTEGRATION REQUIREMENTS
2.4 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. The UPS shall be provided by the Electrical Contractor to cater for the load of all system components as described herein and as recommended by the Supplier considering a maximum of 80% loading and 20% spare capacity for future expansion.

B. Comply with Electrical Section "Static Uninterruptible Power Supply".

2.5 SIGNAL TRANSMISSION COMPONENTS
2.6 CONDUITS, TRUNKING, ENCLOSURES AND FITTINGS

PART 3 - EXECUTION

3.1 WIRING METHODS
3.2 INSTALLATION
3.3 FIRESTOPPING
3.4 GROUNDING
3.5 FIELD QUALITY CONTROL
3.6 OCCUPANCY ADJUSTMENTS
3.7 DEMONSTRATION AND TRAINING

W50A- ADDRESSABLE FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes a microprocessor based, non-coded, addressable fire alarm system with manual and automatic alarm initiation; automatic sensitivity control of certain smoke detectors and multiplexed signal transmission dedicated to fire alarm service only including but not limited to:

1. Fire-alarm control panels.
2. Manual fire-alarm stations.
3. System smoke detectors.
4. Air-sampling smoke detectors.
5. Non-system detectors.
6. Heat detectors.
7. Notification appliances.
8. Device guards.
9. Emergency Voice/Alarm Communications System (EVACS)
10. Firefighters' two-way telephone communication service.
11. Firefighters' smoke-control station.
12. Magnetic door holders.
13. Remote annunciators.
14. Graphic annunciators (panels/workstations).
15. Addressable interface devices.
16. Digital alarm communicator transmitter (DACT).
17. Radio alarm transmitter.
18. Network communications.
19. System printer.

B. Section includes Fire Alarm System interface with the following building services systems:

1. To be developed

C. To be developed

D. Related Sections:

1. To be developed

1.3 REFERENCE STANDARDS

A. To be developed

B. Codes and Standards: System design, operation, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. Local regulations and codes.
2. NFPA 72, National Fire Alarm and Signaling Code.
3. NFPA 101, Life Safety Code.

4. NFPA 1221: Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems
5. NFPA 415, Airport Terminal Buildings, Fuelling Ramp Drainage and Loading Walkways.

C. Codes and Standards: System components shall comply with the applicable requirements and standards addressed within the following references:

1. UL 38: Standard for Manual Signaling Boxes for Fire Alarm Systems
2. UL 217: Standard for Smoke Alarms
3. UL 228: Standard for Door Closers-Holders, With or Without Integral Smoke Detectors.
4. UL 268: Smoke Detectors for Fire Alarm Systems
5. UL 268A: Standard for Smoke Detectors for Duct Application
6. UL 464: Audible Signaling Devices for Fire Alarm and Signaling Systems, Including Accessories
7. UL 521: Standard for Heat Detectors for Fire Protective Signaling Systems
8. UL 864: Standard for Control Units and Accessories for Fire Alarm Systems
9. UL 1480: Speakers for Fire Alarm and Signaling Systems, Including Accessories
10. UL 1481: Standard for Power Supplies for Fire Protective Signaling Systems
11. UL 1711: Standard for Amplifiers for Fire Protective Signaling Systems
12. UL 1887: Standard for Safety Fire Test of Plastic Sprinkler Pipe for Visible Flame and Smoke Characteristics
13. UL 1971: Standard for Signaling Devices for the Hearing Impaired

D. System components, design, operation, installation and workmanship shall comply with the applicable local regulations and code requirements of Authorities Having Jurisdiction. These shall have precedence over other codes and standards indicated, unless otherwise approved by the Employer, in writing.

1.4 DEFINITIONS AND ABBREVIATIONS

A. Definitions

1. Alarm Verification Feature: A feature of automatic fire detection and alarm systems to reduce unwanted alarms wherein smoke detectors report alarm conditions for a minimum period of time, or confirm alarm conditions within a given time period after being reset, in order to be accepted as a valid alarm initiation signal.
2. A " / " used throughout the text between two consecutive words is equivalent to and shall be used interchangeably with " and ".
3. Alarm: A warning of fire danger.
4. Signal: A status indication communicated by electrical or other means.
    a. Alarm Signal: A signal indicating an emergency that requires immediate action, such as a signal indicative of fire.
    b. Evacuation Signal: A distinctive signal intended to be recognized by the occupants as requiring evacuation of the building.
    c. Fire Alarm Signal: A signal initiated by a fire alarm-initiating device such as a manual fire alarm box, automatic fire detector, water-flow switch, or other device in which activation is indicative of the presence of a fire.
    d. Supervisory Signal: A signal indicating the need for action in connection with the supervision of the fire suppression systems or equipment, or the maintenance features of related systems.
    e. Trouble Signal: A signal initiated by the fire alarm system or device indicative of a fault in a monitored circuit or component.
5. Conveying systems: include horizontal and vertical transportation systems (HVTS) such as elevators, moving walks, escalators and dumbwaiters.
6. Positive Alarm Sequence. An automatic sequence that results in an alarm signal, even when manually delayed for investigation, unless the system is reset. It provides a timed delay of a

general alarm signal in a building and at a supervising station. This gives a trained responder up to 3 minutes to investigate the cause of an alarm signal. The time limits to acknowledge the alarm signal and reset the system are designed to assure all alarm system functions are actuated in the event personnel are not available to acknowledge, investigate and reset the alarm. A positive alarm sequence feature can only be used with the specific approval of the Authority Having Jurisdiction.

7. Signaling Line Circuit (SLC): A circuit path between any combination of addressable appliances or devices, circuit interfaces, control units, or transmitters over which multiple system input signals or output signals or both are carried.
8. Soft-Addressing (Auto-Addressing): An intelligent technology which allows the Fire Alarm Control Panel to automatically scan the detection loops and allocate each device with an address number corresponding with its position on the loop.
9. Manual-Addressing: Addressing which is dependent on the user to select the device or location and assign it an address through:
    a. Hard-addressing: by setting numerical binary code tag or switch.
    b. Electronic-addressing: by programming the EEPROM in the device using hand-held field programmer.
10. Notification Appliance Circuit (NAC): A circuit or path directly connected to notification appliances.
11. Emergency Voice/Alarm Communications System (EVACS): Dedicated manual or automatic facilities for originating and distributing voice instructions, as well as alert and evacuation signals pertaining to a fire emergency, to the occupants of a building.

B. Abbreviations

1. To be developed

1.5 SCOPE OF WORK

A. The system shall include all required hardware, raceways, interconnecting wiring, end of line and other necessary circuit elements and software to accomplish the requirements of this Specification and the contract drawings, whether or not specifically mentioned herein.

B. Provide the following:

1. MFACP/FACP, manual stations, automatic fire detectors, notification appliances, wiring, wire-ways and all accessories to form a complete system.
2. Remote annunciator(s).
3. Graphic annunciator(s).
4. Networking of MFACP and FACP.
5. Firefighters telephone communication service.
6. Firefighters' smoke-control station
7. Digital alarm communicator transmitter.
8. Emergency Voice/Alarm Communications System (EVACS).
9. System printer.
10. Interface with the Public Address System.
11. Interface with other building services systems and with the BMS.

C. To be developed

1.6 COORDINATION

A. To be developed

1.7 SUBMITTALS

A. The Contractor shall not perform any part of the work requiring submittal and review of shop drawings, product data or samples until Engineer / Employer has approved the respective submittal. Such work shall be in accordance with approved submittals:

1. Product data: For each type of product.
2. Shop Drawings.
3. Wiring diagrams to show typical wiring schematics.
4. System Operation: Include system architecture and performance requirements.

B. To be developed

C. Product Certificates: signed by manufacturers of equipment and /or software certifying that furnished products comply with contract requirements (Declaration of Conformity) and performance.

D. Seismic Qualification Certificates: To be developed

E. Manufacturer's Endorsement: To be developed

F. General Submittal Requirements: To be developed

G. Contractor shall deliver signed Warranty.

H. Testing Plan: To be developed

I. Product Data: To be developed

J. Sound Levels: To be developed

K. System Graphics: To be developed

L. Prepare a risk assessment plan: To be developed

M. Shop Drawings: For fire alarm system: To be developed

N. Qualifications: To be developed

O. Closeout Submittals (Record Documents): To be developed

P. Operation and Maintenance Data: For fire alarm systems and components to include in operation, and maintenance manuals: To be developed

1.8 QUALITY ASSURANCE

A. To be developed

B. Installer Qualifications To be developed

C. Manufacturer Qualifications: To be developed

D. Source Limitations: To be developed

E. Certification

1. All components of the fire alarm system including system hardware and software shall be:

a. UL listed

b. Listed, Approved and Registered by the Civil Defense Material Approval Department

2. The entire fire alarm system including integration arrangement with the BMS, the Access Control, PAS and other Building Services Systems shall be UL listed and suitable for life safety and fire alarm applications.

3. Obtain certification according to NFPA 72 by: To be developed

F. Equipment Country of Origin: To be developed

G. Installer Qualifications: Installation shall be by personnel certified to operate as a fire alarm system installer in the region.

1.9 DELIVERY, STORAGE AND HANDLING

A. Comply with Division 01, Section “Product Requirements”.

1.10 PROJECT/SITE CONDITIONS

A. To be developed.

1.11 WARRANTY

A. Special Warranty

1. To be developed

B. Experimental Period

1. To be developed

C. Taking Over of the System

1. To be developed

D. Warranty Period

1. The Contractor shall include a statement of warranty on the entire system and on the individual pieces of equipment for two years from the date of taking over of the system.
2. To be developed

1.12 MAINTENANCE AND SUPPORT DURING WARRANTY PERIOD

A. To be developed

1.13 SPARE PARTS AND EXTRA MATERIAL

A. Contractor shall handover manufacturer’s recommended spare parts for all major components in the system for two years fault-free operation.

B. To be developed

PART 2 - PRODUCTS

2.1 STANDARD COMMERCIAL PRODUCTS

A. Refer to Division 01 Section "Product Requirements".

2.2 SEISMIC PERFORMANCE REQUIREMENTS

A. Seismic Performance: Fire alarm control panel and raceways shall withstand the effects of earthquake motions determined according to ASCE/SEI 7

2.3 SYSTEM DESCRIPTION

A. To be developed

B. Control of System: By the MFACP/MFS/FACP.

C. System Supervision: To be developed.

D. Priority of Signals: To be developed.

E. Noninterference: To be developed.

F. System Reset: To be developed.

G. All operations shall be according to the approved Cause & Effect Matrix.

H. The Fire Command Center (FCC): To be developed

I. Source Limitations for Fire alarm System and Components: To be developed.

J. Fire alarm signal initiation shall be by one or more of the following devices and systems: To be developed

K. Supervisory signal initiation shall be by one or more of the following devices and systems: To be developed

L. System Trouble signal initiation shall be by one or more of the following devices and actions: To be developed

M. System Trouble and Supervisory Signal Actions: To be developed

N. Alarm Silencing, System Reset and Indication: Controlled by switches in the MFACP/MFS/FACP: To be developed

O. Stairwell and Elevator Shaft Pressurization: To be developed

P. Smoke-Alarm Verification: To be developed

Q. Notification-Appliance Circuit: To be developed

R. Elevators: To be developed

S. Door Controls: To be developed

T. Voice/Alarm Signaling Service: To be developed

U. Printout of Events: To be developed

V. Power Supply: To be developed

W. Communication of Events:

X. FACP Alphanumeric Display: To be developed

2.4 MAIN FIRE ALARM CONTROL PANEL (MFACP)

A. The MFACP shall be field-programmable, microprocessor-based, modular, power-limited design with electronic modules:

1. To be developed

2.5 FIRE ALARM CONTROL PANELS (FACP)

A. Description: FACPs shall be identical to and compatible with the MFACP in all respect, capable of operating the system on a stand-alone basis. Each panel maintains the status and control of its own dedicated circuit points.

1. Comply with UL 864.

B. The FACP shall serve as the interface between initiating fire devices, controlled signalling devices, and each fire alarm node. The supervised multiplex communication port shall be an integral part of the FACP.

C. Each FACP shall be powered from a local power supply, and shall provide all power necessary for its own operation and related components, including standby power. Contractor shall verify by calculations that the voltage drop limits on the lines feeding the different components do not exceed the limits recommended by manufacturer, and shall rectify wherever needed.

D. FACPs shall be used to house amplifiers, batteries, and power supplies to allow true distributed processing and amplification.

2.6 ADDRESSING MECHANISM

A. To be developed

2.7 MANUAL FIRE ALARM STATIONS

A. To be developed

2.8 SYSTEM SMOKE DETECTORS

A. General Requirements:

1. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire alarm control panel.
2. Base Mounting, Self-Restoring, Integral Visual-Indicating Light, Remote Control from the fire alarm control panel for calibration, sensitivity, and alarm condition
3. To be developed

B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire alarm control panel and shall be able to identify the detector's location within the system and its sensitivity setting.
2. To be developed

C. Duct Smoke Detectors: Photoelectric type.

1. To be developed

2.9 PROJECTED BEAM SMOKE DETECTORS

A. To be developed

2.10 CARBON MONOXIDE DETECTORS

A. To be developed

2.11 MULTI-CRITERIA DETECTORS

A. To be developed

2.12 NON-SYSTEM DETECTORS

A. To be developed

2.13 HEAT DETECTORS

A. To be developed

B. Heat Detector, Combination Type/ Fixed-Temperature Type/ Continuous Linear Heat-Detector

2.14 VERY EARLY WARNING FIRE DETECTION (VEWFD) SYSTEM – SPOT TYPE DETECTOR

A. Very Early Warning Fire Detection (VEWFD) Systems shall utilize very high sensitivity spot type smoke detectors that are specifically designed and tested to detect low-energy fires before the fire conditions threaten data processing and/or telecommunications service (Telecom Rooms, Control Rooms, …).

B. To be developed

2.15 AIR-SAMPLING SMOKE DETECTOR

A. To be developed

2.16 NOTIFICATION APPLIANCES

A. To be developed

B. Bells/Horns

C. Visible Notification Appliances

2.17 FIREFIGHTERS' TWO-WAY TELEPHONE COMMUNICATION SERVICE

A. Dedicated, two-way, supervised, telephone voice communication links between fire alarm control panel, the fire command center, and remote firefighters' telephone stations.

B. To be developed

2.18 FIREFIGHTERS' SMOKE-CONTROL STATION

A. To be developed

2.19 MAGNETIC DOOR HOLDERS

A. To be developed

2.20 REMOTE INDICATING LAMP

A. To be developed

2.21 GRAPHIC ANNUNCIATOR

A. To be developed

2.22 REMOTE ANNUNCIATOR

A. To be developed

2.23 FIRE ALARM NETWORK

A. To be developed

2.24 SYSTEM POWER SUPPLY

A. To be developed

2.25 ADDRESSABLE INTERFACE DEVICE

A. Monitor Module/Relay Module/ Control Module:

B. To be developed

2.26 DIGITAL ALARM COMMUNICATOR TRANSMITTER (DACT)

A. To be developed

2.27 RADIO ALARM TRANSMITTER

A. To be developed

2.28 SYSTEM PRINTER

A. To be developed

2.29 DEVICE GUARDS

A. To be developed

2.30 WIRE AND CABLE

A. To be developed

B. Fire Resistant Cables

C. Grounding Components

2.31 CONDUITS, TRUNKING AND FITTINGS

A. To be developed

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

3.2 WIRING INSTALLATION

3.3 IDENTIFICATION

3.4 GROUNDING

3.5 FACTORY ACCEPTANCE TESTS

3.6 FIELD QUALITY CONTROL

3.7 CLEANING

3.8 OCCUPANCY ADJUSTMENTS

3.9 DEMONSTRATION AND TRAINING

W52A - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. This Section includes lightning protection for buildings and associated structures and includes requirements for lightning protection systems components including, but not limited to, the following:
   1. Air Termination Network.
   2. Down Conductors.
   3. Earth Termination Network.
   4. Bonding.
   5. Accessories.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Standards: Comply with the following standards:

   1. IEC 62305 "Protection Against Lightning".
   2. IEC 62561 "Lightning Protection System Components".

110.020 DEFINITIONS AND ABBREVIATIONS

110.030 TERMS USED

A. The following terms used on Drawings and in the Specification are synonymous and may be used interchangeably:

   1. "Earth" and "Ground".
   2. "Earthing" and "Grounding".

120.000 SYSTEM DESCRIPTION

120.010 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Provide lightning protection system materials and components that comply with IEC 62561 and with approved manufacturer's standard design, in accordance with published product information and the Standards specified in this Section.

B. Provide air terminals, bonding plates, conductors, connectors, conductor straps, fasteners, earthing plates, earthing rods, rod clamps, splicers and other components required for a complete system that meets the Standards specified in this Section.

C. Roof Conductors: 70 mm^2 soft drawn stranded copper cable covered with PVC of approved color or bare, high conductivity, annealed copper strip, 25 x 3 mm.

D. Earth Rod: 16 mm diameter high strength, low carbon steel core of high tensile strength (600 N/mm2), with 99.99% pure electrolytic copper molecularly bonded into steel core, 0.25 mm minimum thickness.

   1. Driving Head: High strength steel.
   2. Couplings: Long length silicon bronze, internally threaded.
   3. Threads: Rolled onto rod to ensure uniform layers of copper and strength.
   4. Minimum Length of Rod: 2.4 m.

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E. Inspection (Earth) Pit: Precast concrete construction of dimensions shown on Drawings, with heavy duty cover and brass plate engraved 'Earth Pit Below' inset in cover.

1. Provide one pit for each earth rod.

F. Bonding Conductors: High conductivity, bare annealed copper tape, 20 x 3 mm minimum dimensions, or 50 mm2 soft drawn stranded copper cable covered with PVC of approved color.

G. Accessories: Supports, joints, fasteners, clamps, bonds, test links, etc., shall be copper or copper alloy and specially manufactured for the purpose. Clamps and connectors shall be specifically designed and sized for clamping and connecting to the various shapes and surfaces of bonded metalwork. Provide bimetallic connectors between different materials. Galvanized or plated steel nails, screws and bolts will not be accepted on copper installations.

H. Flexible Bonding Straps: Flexible annealed copper braid, 20 x 3 mm, suitable for bonding flat surfaces, cut to length required and with drilled flat terminals for bolted connections. Provide special bimetallic alloy terminals for joining to aluminum conductive parts.

I. Down Conductors: High conductivity, copper tape 25 x 3 mm or 70 mm2 soft drawn stranded copper cable, bare or covered with PVC of approved color as shown on drawings.

J. Test Links: Two-bolt split-coupling, copper alloy, made to join two ends of down conductor specified. Plate indicating position and number of electrodes shall be fitted above each test link.

120.020 TECHNICAL REQUIREMENTS

A. Flat Concrete Roofed Buildings Air Termination Network: Provide horizontal conductors around periphery (or parapet), and along inner edges of roofs that are higher than adjacent parts, unless they fall in zone of protection of a higher conductor. Install horizontal conductors in a mesh of proper size for the protection level required, as shown on drawings. Join all elements of lightning protective system together. Additionally, provide air termination horizontal loops around building façade for structures above 60m and 120m as per the standard requirement or as shown on Drawings; bonded to steel reinforcement and exposed metal parts as specified and required by the standard.

B. Use Air Rods (Finials/Terminals) in the air termination network, dimensions as per the code requirements; as necessary and/or shown on drawings.

C. Peripheral/External Down Conductors: Spaced at 10m. Every down conductor shall:

1. Have test link above earth for testing earth termination network.
2. Be protected against corrosion.
3. Terminate in an earth electrode (horizontal or vertical as per design requirements).
4. Be insulated and installed in PVC conduit from test link to electrode connection point (to reduce potential gradient at earth level which otherwise would be lethal to humans or animals).

D. Have lateral connection of down conductors (intermediate level ring conductors) at earth level and at proper intervals on building façade as per standard requirements or shown on drawings.

E. Add extra internal down conductors every 40m in large and flat structures with dimensions exceeding four times the spacing between down conductors.

F. Copper Earth Electrode: Provide type A, B or a combination of both as necessary or shown on drawings to achieve a maximum resistance to earth of 10 Ohm.

G. Isolation of earth electrode for testing shall be possible.

H. Bonding of ground electrodes of all services: Provide bonding between the earth termination network of the lightning protection system and earth networks of all other services to ensure a common earthing system. The resistance to ground should, in this case be the lowest value needed for any of the individual services. Combined resistance to ground of whole network is not to exceed 10 Ohm.

I. Joints and interconnections in earth termination network shall be exothermic welds except that down conductor shall be connected by a single or multi-conductor bolted U- connector clamp at earth pits.

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J. Bonding: Bond all metalwork in or on outside of structure to the lightning protection system at points above the test joint (test link) to avoid side flashing. Metalwork includes but is not necessarily limited to: water pipes, tanks, sign structures, communication supports, metal sheaths and exposed parts of electrical installations, vents, exterior metal staircases, metal window frames, vent pipes, steel doors or door frames, main earthing terminal or bar of electrical installation and reinforcing bars of concrete structures if these are in continuous electrical contact.

K. Bond metal leaving or entering a structure (having system continuity such as water piping, etc.), as follows:

1. As directly as possible to the earth termination.
2. Near point at which service enters or leaves the structure.
3. At nearest earth point or at nearest main earthing terminal or bar of protective earthing system.

If direct bonding is not acceptable by authorities and/or parties concerned, SPDs shall be used.

L. Test Links: provide a test joint on each down conductor at the connection of the earth termination, (except when reinforced steel inside columns is used as natural down conductor).

M. Surge Protection Devices where specified or required by drawings shall be as follows:

1. SPD's test requirements shall be compliant with

a) IEC 61643-11 for power systems,
b) IEC 61643-21 for telecommunication and signaling systems.

2. Selection and installation of a coordinated SPD protection shall comply with

a) IEC 61643-12 and IEC 60364-5-53 for protection of power systems,
b) IEC 61643-22 for protection of telecommunications and signaling systems.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and Division A Specification Sections, apply to this Section.

210.000 RELATED SECTIONS

A. Related Sections include the following:

1. Division V Section "Basic Electrical Materials and Methods".
2. Division Y Section "Earthing and Bonding".
3. Division W Section "Surge Protective Devices ".

PART 3 PRODUCTS AND WORKMANSHIP

300.000 MATERIALS

300.010 MANUFACTURERS

A. Approved Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

1. Furse, W.J. and Co.
2. Harger Lightning Protection, Inc.
3. Independent Protection Company, Inc.
4. Wallis
5. DEHN
6. Helita

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310.000 QUALITY MANAGEMENT

310.010 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who has specialized in installing lightning protection systems similar in material, design and extent to those indicated for this Project and whose work has resulted in installations with a record of successful in-service performance.

320.000 SUBMITTALS

A. Product Data: Submit data for air terminals, fasteners, test links earth point and rods, connectors, wall inserts and bolts and any accessories forming part of the lightning protective system.

B. Shop Drawings: Detail the lightning protection system, including air-terminal locations, conductor routing and connections, and bonding and earthing locations and provisions. Include indications for use of raceway and sleeves, and data on how concealment requirements will be met.

C. Record (As-Built) Drawings: Indicate nature of soil, special earthing arrangements, date and particulars of additives to soil or in bore-holes if used, test conditions and results obtained.

D. Records: Submit the following:

1. Actual layout and components of the system.
2. Nature of soil and characteristics and any special earthing arrangement.
3. Test conditions and results.

E. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects/engineers and owners, and other information specified or required by Engineer.

330.000 EXECUTION

330.010 INSTALLATION

A. Install lightning protection components and systems according to IEC 62305.

B. Install conductors with direct paths from air terminals to earth connections. Avoid sharp bends and narrow loops.

C. Conceal the following conductors:

1. System conductors.
2. Down conductors.
3. Interior conductors.
4. Conductors within normal view from exterior locations at grade within 60 m of building.
5. Notify Engineer at least 48 hours in advance of inspection before concealing lightning protection components.

D. Cable Connections: Use approved exothermic-welded connections for all conductor splices and connections between conductors and other components.

E. Bond lightning protection components with intermediate-level interconnection loop conductors to earthed metal bodies of building at 20m intervals.

F. Down conductors shall follow most direct path between air terminals and earth pit, avoiding sharp bends and narrow loops. Where necessary, the formation of loops in down conductors shall not violate the code restrictions in terms of the gap formed across the loop.

G. Mechanical Protection of Down Conductors: Unless otherwise shown on drawings, provide PVC conduit, starting 0.3 m below earth and to a height of 1.9 m above earth with proper fixing for the conduit. Test link shall be positioned 2 m above earth.

H. Joints and Bonds: Clean and treat contact surfaces with non-corrosive compound. Protect joints between dissimilar metals from moisture by inert, tenacious material, and with overlapping joints

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not less than 30 mm long. Provide as few joints and bonds as possible and make mechanically and electrically effective by clamping, bolting or exothermic welding. Cross-sectional areas of joints and bonds shall not be less than that of main conductor.

I. Bond exposed metal parts of structure to lightning protective system if clearance between any element of lightning system and metal part is less than 1800 mm or the distance allowed by the specified Standard, whichever is smaller.

J. Inspection (Earth) Pit: Extend 150 mm below top of earth rod. Cover earth rod connector with suitable protective compound, which can be easily removed for inspection. Connector shall not be covered with backfill material and shall remain clean.

330.020 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions would cause deterioration or corrosion of conductors.

330.030 FIELD QUALITY CONTROL

A. Periodic Inspections: Perform periodic inspections during installation of lightning protection systems and at Substantial Completion.

330.040 COORDINATION

A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.

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W57 - SURGE PROTECTIVE DEVICES

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. Section includes factory installed or field-mounted SPDs for:

1. Low-voltage (up to 1000 V) power distribution and control equipment whose specific requirements are covered under Articles 120.01 to 120.06 inclusive.
2. Telecommunications and Signal Processing Equipment whose specific requirements are covered under Articles 120.07 to 120.010 inclusive.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Codes and Standards: Comply with the following standards:

1. IEC 61643-11.
2. IEC 61643-12.
3. IEC 61643-21.
4. IEC 61643-22.
5. BS 7671 (IET Wiring Regulations – Latest Edition).
6. IEC 61000-6-3.
7. IEC 61000-4-5.

110.020 DEFINITIONS AND ABBREVIATIONS

A. I_n: Nominal discharge current.

B. I_{imp}: Impulse current.

C. I_{max}: Maximum discharge current.

D. I_{cw}: Combination wave generator short-circuit current.

E. U_c: Maximum continuous operating voltage.

F. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.

G. GDT: Gas discharge tube.

H. SAD: Silicon avalanche diode.

I. SPD: Surge protective device.

J. TOV: Temporary overvoltage.

K. U_p: Voltage protection level.

L. U_{oc}: Open circuit voltage.

M. U_T: Temporary overvoltage test value.

N. f_G: Cut-off frequency is equivalent to the frequency which induces an insertion loss of 3 dB under certain test conditions as per IEC 61643-21. Unless otherwise indicated, this value refers to a 50 Ω system

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120.000 SYSTEM DESCRIPTION

120.010 GENERAL REQUIREMENTS FOR AC POWER SURGE PROTECTIVE DEVICES

A. Maximum continuous operating voltage (U_c) of the SPD shall be equal to 110% of the nominal system voltage as a minimum or the next higher rating to ensure the ability of the system to withstand temporary r.m.s overvoltage (swell conditions), unless otherwise shown on the Drawings.

B. The SPD shall be suitable for a supply main's frequency between 47 Hz and 63 Hz.

C. All installed SPDs shall be connected in common mode to eliminate overvoltage between each phase and earth and between neutral and earth, unless otherwise specified.

D. SPDs shall have the following features and accessories:

1. Integral or external fused-disconnect switch. Fuses shall be current limiting type to IEC 60269 with short circuit interrupting capacity 120 kA as a minimum.
2. Indicator light display for protection status and end of life.
3. Control interface: SPD shall be equipped with dry contacts for monitoring and displaying the SPD's status and alarms from the BMS. As an alternative, software interface with BMS may be provided. Coordinate with BMS supplier for interface requirements.
4. Surge counter, for SPDs in compliance with ANSI/UL Standards.

E. SPDs shall comply with IEC 61000 For EMC.

F. SPDs installed adjacent to the protected equipment shall have galvanized and electrostatic painted enclosure with IP 54 degree of protection to IEC 60529 and provided with suitable DIN rails for SPD and fused-disconnect switch fixation, unless otherwise recommended by the manufacturer and approved by the Engineer.

G. Generally, SPDs shall be installed as follows, unless otherwise specified or shown on the Drawings:

1. Class I+II SPDs shall be installed at:

a) Incomer(s) of all MDB(s).
b) Incomer(s) of EMDB(s) / Synchronization switchboards.
c) Incomer of all MCC(s) fed directly from transformer.
d) Utility incomer of ATS(s) fed directly from transformer.

2. Class I SPDs shall be installed at:

a) Roof mounted / outdoor equipment control panel, unless otherwise recommended by the equipment manufacturer.

3. Class II SPDs shall be installed at:

a) Distribution panels.
b) Utility incomer of ATS(s) fed from main distribution board / distribution panels.
c) Incomer of MCCs / MCPs fed from main distribution board / distribution panels.
d) Foundation distribution cabinets for data centers.

4. Class III SPDs shall be installed at:

a) Power distribution units for data centers.
b) Final distribution panelboards feeding sensitive equipment.
c) Outdoor luminaires installed at high masts and street lighting poles, unless otherwise recommended by the manufacturer.

H. All SPDs shall be installed within or adjacent to the protected equipment within a distance not exceeding 10 m. Where distance between two consecutive SPDs is less than 10 m, the downstream SPD is not required.

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120.020 COMBINED CLASS I + II OR TYPE 1 HYBRID SURGE PROTECTIVE DEVICES

A. Combined surge protective devices shall utilize MOV and GDT technologies and shall provide common mode and differential mode protection to eliminate overvoltage between each phase and neutral and between neutral and earth.

B. Class I + II surge protective devices shall be provided where specified or shown on the Drawings.

C. SPDs: Comply with IEC 61643-11, combined Class I + Class II.

D. SPD shall be tested for I_{imp} simulated with 10/350 microseconds waveform, with the following parameters for common mode: I_{imp} 100 kA within 50 micro seconds, charge (Q) 50 As within 5 ms and energy (W/R) 2500 kJ/Ohm within 5 ms, unless otherwise recommended by the manufacturer and approved by the Engineer.

E. SPD shall be tested for I_{imp} simulated with 10/350 microseconds waveform, with the following parameters for differential mode: I_{imp} 25 kA within 50 micro seconds, charge (Q) 12.5 As within 5 ms and energy (W/R) 156 kJ/Ohm within 5 ms, unless otherwise recommended by the manufacturer and approved by the Engineer.

F. Voltage protection level (U_p) shall not exceed 1500 V.

G. Short Circuit Withstand Capability (I_{sccr}): Match the Switchboard short circuit level as a minimum.

H. Common Mode Nominal Discharge Current (I_n): 100 kA with 8/20 microseconds waveform unless otherwise recommended by the manufacturer and approved by the Engineer.

I. Differential Mode Nominal Discharge Current (I_n): 25 kA with 8/20 microseconds waveform unless otherwise recommended by the manufacturer and approved by the Engineer.

J. Maximum Discharge Current (I_{max}): 100 kA with 8/20 microseconds waveform.

K. SPDs temporary overvoltage withstand shall comply with IEC 61643-11 requirements.

L. As an alternative to combined Class I+II SPD, hybrid surge protective devices may be used. Hybrid SPDs shall be constructed using a primary and secondary stage hybrid transient suppression system separated by suitable line inductive impedance to ANSI/UL 1449. The primary stage shall utilize SAD technology, while the secondary stage shall be constructed using multiple surge current diversion modules utilizing MOV technology and tested for manufacturing defects. The SAD module shall not be self-sacrificing to protect the system; rather it shall provide immediate transition to the secondary stage when subjected to potentially harmful levels. The modules shall be designed and constructed in a manner that ensures surge current sharing.

120.030 CLASS I SURGE PROTECTIVE DEVICES

A. Class I surge protective devices shall utilize MOV technology.

B. Class I surge protective devices shall be provided where specified or shown on the Drawings.

C. SPDs: Comply with IEC 61643-11, Class I.

D. SPD shall be tested for I_{imp} simulated with 10/350 microseconds waveform, with the following parameters: I_{imp} 25 kA within 50 micro seconds, charge (Q) 12.5 As within 5 ms and energy (W/R) 156 kJ/Ohm within 5 ms.

E. Voltage protection level (U_p) shall not exceed 2500 V.

F. Short Circuit Withstand Capability (I_{sccr}): 100 kA_{rms} (220 kA_{peak}) as a minimum.

G. Nominal Discharge Current (I_n): 25 kA with 8/20 microseconds waveform, unless otherwise recommended by the manufacturer and approve by the Engineer.

H. SPDs temporary overvoltage withstand shall comply with IEC 61643-11 requirements.

120.040 CLASS II SURGE PROTECTIVE DEVICES

A. Class II surge protective devices shall utilize MOV technology.

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B. Class II surge protective devices shall be provided where specified or shown on the Drawings.

C. SPDs: Comply with IEC 61643-11, Class II.

D. SPD shall be tested with simulated 8/20 microseconds waveform, with I_n 12.5 kA.

E. Voltage protection level (U_p) shall not exceed 1500 V.

F. Short Circuit Withstand Capability (I_{sccr}): 50 kA_{rms} as a minimum.

G. Maximum Discharge Current (I_{max}): 25 kA with 8/20 microseconds waveform.

H. SPDs temporary overvoltage withstand shall comply with IEC 61643-11 requirements.

120.050 CLASS III SURGE PROTECTIVE DEVICES

A. Class III surge protective devices shall utilize MOV technology and shall provide common mode and differential mode protection to eliminate overvoltage between each phase and neutral and between neutral and earth.

B. Class III surge protective devices shall be provided where specified or shown on the Drawings.

C. SPDs: Comply with IEC 61643-11, Class III.

D. SPD shall be tested with a simulated combination wave of 8/20 microseconds waveform for short circuit current and 1.2/50 microseconds waveform for open circuit voltage with U_{oc} 6 kV.

E. Voltage protection level (U_p) shall not exceed 1500 V.

F. Short Circuit Withstand Capability (I_{sccr}): 6 kA_{rms} as a minimum.

G. Nominal Discharge Current (I_n): 3 kA with 8/20 microseconds waveform.

H. SPDs temporary overvoltage withstand shall comply with IEC 61643-11 requirements.

120.060 IDENTIFICATION

A. The following information shall be provided by the manufacturer on the nameplate as a minimum:

1. Manufacturer's name and model number.
2. Maximum continuous operating voltage.
3. SPD class and discharge parameters for each mode of protection declared by the manufacturer:

    a) Class I+II, I_{imp} in kA and I_n in kA.
    b) Class I and I_{imp} in kA.
    c) Class II and I_n in kA.
    d) Class III and U_{oc} in kV

4. Nominal discharge current.
5. Voltage protection level.
6. Identification of terminals.
7. Compliance standards.

120.070 PROTECTION OF TELECOMMUNICATIONS AND SIGNAL PROCESSING EQUIPMENT

A. Telecommunications and signal processing equipment, being sensitive devices susceptible to destruction by surge voltages induced by lightning or by electrical switching operations, shall be protected by SPD's.

B. The SPD's shall be deployed based on the source of the surge and its intensity at the boundary of each lightning protection zone (LPZ $0_A/0_B/1/2$) as defined by IEC 62305-4.

C. SPD's shall be properly designed to take into account the surge energy that they will be subjected to and to limit the transient over-voltages to safe levels for equipment within the protected zone.

D. SPD's shall be able to limit conducted interference to a safe level so that the immunity of the protected terminal equipment is not exceeded in accordance with the requirements of the immunity

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and the test set-up described in EN 61000-4-5. The voltage protection level has to be adapted to the immunity of the equipment to be protected.

E. SPD's shall comply with the standardized test waveforms with peak currents used to test SPD's at each LPZ boundary given in IEC 61634-21 Table 3. Accordingly, each protective device shall be labeled and tested to multiple categories and performance classes.

F. Identification, Documentation and Marking

1. Identification, documentation and marking shall be in accordance with IEC 61643-21:
2. The SPDs shall be clearly marked with the following items:

a) The Manufacturer's name or trademark.
b) Model number.
c) Manufacturing traceability.
d) The maximum continuous operating voltage.

3. The following information shall be either marked on the body of the SPD or included in the submittals for review. For each test performed on the SPD, the test conditions shall be stated in the documentation:

a) Manufacturer's name or trademark
b) Year and week of manufacture, or serial number.
c) Model number.
d) Service conditions.
e) Maximum continuous operating voltage U_c (AC and/or DC).
f) Rated current.
g) Voltage protection level U_p.
h) Impulse reset (if applicable).
i) AC durability.
j) Impulse rating (according to IEC 61643-21 Table 3 - category and corresponding parameters e.g. C2: 2k V/ 1kA).
k) Transmission characteristics (appropriate to the intended SPD use).
l) Additional information such as surge currents I_n, I_{imp}, series resistance.
m) SPD Category and rating.

G. SPD's for telecommunications and signal processing equipment may be classified into three basic application groups:

1. Telephone and data transmission equipment.
2. Data processing networks.
3. Radio communication equipment.

120.080 SPD'S FOR TELEPHONE AND DATA TRANSMISSION EQUIPMENT

A. Surge protectors for telephone and data transmission equipment are divided into three types :

1. Surge protectors for telecom networks.
2. Surge protectors for industrial networks.
3. Surge protectors for Local Area Networks (LANs).

B. Surge protectors for telecom networks.

1. Designed to protect telecom transmission devices such as PBX, modems, data terminals.
2. Designed and selected to fit into the existing installations such as:

a) Mounting on DIN rail.
b) Insertion in connection strips.
c) Wall mounting.
d) Mounting on telecom Main Distribution Frames.
e) Plug-in on termination outlets.

C. Surge protectors for industrial networks.

1. Equipment to be protected shall include but shall not be limited to:

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a) Fire detection system
b) Access control system
c) Input / Output cards
d) Industrial process equipment
e) SCADA system
f) Converters and interfaces
g) Actuators
h) Probes
i) Transmission systems

2. Surge protectors shall be designed to fit on DIN rail and shall be available in various configurations, as required.

a) Number of protected wires: 1 wire or 2 pairs.
b) Plug-in modules: removable to facilitate maintenance.
c) Transmission and protection of the shield wire.

D. General Features of SPD's for telephone and data transmission equipment:

1. SPD's shall be based on a multi-stage hybrid design that combines a high discharge current capacity with fast response time to provide:

a) A nominal discharge current greater than 5 kA at 8/20 µs impulse.
b) An ultra-fast response time < 1 ns.
c) Safe operation in end of life scenarios (fail-safe behavior: short circuit in case of removal of device with no line-cut-off).
d) Low insertion loss.

E. Protection Configurations

1. Protection configurations shall be selected based on the type of network being protected:

a) Standard Protection: Used mainly for the analog telecom network (PSTN):

1) A combination of a 3-electrode gas discharge tube, line resistors and fast clamping diode.

b) Enhanced Protection: For very low voltage transmission lines.

1) A combination of a 3-electrode gas discharge tube, line resistors and 3-pole clamping diode.

c) Line + Shield Protection: Transmission and protection for the shield wire.
d) K20 Protection: Complying with the ITU-T K20 International recommendation:

1) A combination of a 3-electrode gas discharge tube, fast clamping diodes and thermistors.

e) Low Capacitance Protection: For high bit rate links (> 1 Mbit/s):

1) A combination of a 3-electrode gas discharge tube, line resistors and 3-pole low capacitance diodes.

f) Cat 6/Cat6A Protection: Designed for very high bit rate LAN (up to 1000 Mbit/s):

1) A combination of a 3-pole low capacitance diode and MOV.

2. Below Table shows characteristics of typical protection configurations of combined lightning protection and surge arresters that shall be required at Service Entrances (LPZ 0_A-LPZ 2 or higher) of common building services. Final selected configuration shall be based on type of line to be protected, number of lines to be protected and type of installation in addition to the recommendations of the protected equipment manufacturer.

Characteristic	Application			
	Telecom	Industrial	Industrial	Industrial

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	Telecom systems, ADSL, etc.	RS232	Modbus / RS485 / Profibus DP/FMS	LON-Bus (Echelon)
Nominal Voltage (U_n)	180V	12V	5V	5V
Maximum Continuous Operating DC Voltage (U_c)	180V	15V	6V	6V
Maximum Continuous Operating AC Voltage (U_c)	127V	10.6V	4.2V	4.2V
Maximum Current at 45 Deg. C (I_L)	750mA	750mA	1000mA	1000mA
D1: Total lightning impulse current (10/350 µs) (I_{imp})	10 kA	10 kA	10 kA	10 kA
D1: Lightning impulse current (10/350 µs) per line (I_{imp})	2.5 kA	2.5 kA	2.5 kA	2.5 kA
C2: Total nominal discharge current (8/20 µs) (I_n)	20 kA	20 kA	20 kA	20 kA
C2: Nominal discharge current (8/20 µs) per line (I_n)	10 kA	10 kA	10 kA	10 kA
Voltage protection level line-line for I_{imp} D1 (U_p)	≤270V	≤50V	≤25V	≤25V
Voltage protection level line-earth for I_{imp} D1 (U_p)	≤550V	≤37V	≤550V	≤550V
Voltage protection level line-line at 1 kV/µs C3 (U_p)	≤250V	≤38V	≤11	≤9
Voltage protection level line-earth at 1 kV/µs C3 (U_p)	≤550V	≤19V	≤550	≤550
In-line resistance	1.8 ohms	1.8 ohms	1.0 ohms	1.0 ohms
Cut-off frequency line-line (f_G)	25 MHz	2.7 MHz	100 MHz	1 MHz
Wiring	2 pairs	4 wires	2 pairs	2 pairs

120.090 DATA PROCESSING NETWORKS

A. Ethernet network surge protectors shall be designed for computer networks with very fast data transfer speeds, up to 1 Gbit/s networks of Category 5E/6/6A and PoE / PoE+ installations.

B. Surge protectors for Local Area Networks (LAN's) shall be based on a combination of 3-pole gas tubes and fast clamping diodes.

C. Surge protectors shall be equipped with standard data processing connectors (such as RJ45 connectors) and shall be available in either a single enclosure to protect terminal equipment or to fit in a 19'' rack to protect at the switch level.

D. Video Transmission

1. Video Transmission shall be protected at the remote equipment level as well as at the local digital recording devices.
2. Surge protectors for video transmission shall be designed to support different configurations:

a) Analog Cameras: combining analog video and power supply protection into a single unit.
b) IP Camera: combining Ethernet and power supply protection in a single unit.
c) Power Over Ethernet (PoE) Video: designed for Power Over Ethernet applications.

E. The installation of surge protectors on data-processing networks shall be applied in accordance with IEC 61643-21 in areas of high electromagnetic disturbance, inter-building networks and wide area networks.

F. Below Table shows characteristics of typical protection configuration for SPD's at transition from lightning protection zone (LPZ 0_B to LPZ 2 and higher). Final selected configuration shall be based on type of network, application voltage level and data transmission speed.in addition to the recommendations of the protected equipment manufacturer.

Characteristic	Application
	Industrial Ethernet, PoE+, Cat 6, Class E_A
Nominal Voltage (U_n)	48V

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Maximum Operating DC Voltage (U_c)	48V
Maximum Operating AC Voltage (U_c)	34V
Maximum Continuous DC Voltage Pair-Pair (PoE) (U_c)	57V
Nominal Current (I_L)	1A
C2: Nominal discharge current (8/20 µs) line-line (I_n)	150A
C2: Nominal discharge current (8/20 µs) line-earth (I_n)	2.5 kA
C2: Total nominal discharge current (8/20 µs) line-earth (I_n)	10 kA
C2: Nominal discharge current (8/20 µs) pair-pair (PoE) (I_n)	150A
Voltage protection level line-line for I_n C2 (U_p)	≤190V
Voltage protection level line-earth for I_n C2 (U_p)	≤600
Voltage protection level line-line for I_n C2 (PoE) (U_p)	≤600
Voltage protection level line-line at 1 kV/µs C3 (U_p)	≤145V
Voltage protection level line-earth at 1 kV/µs C3 (U_p)	≤500V
Voltage protection level pair-pair at 1 kV/µs C3 (PoE) (U_p)	≤600V
Insertion loss at 250MHz	≤2.0 dB
Transmission class to EN50173-1	Class E_A
Wiring	8 wires + shield

120.100 RADIO COMMUNICATION EQUIPMENT

A. General features of surge protectors for radio communication equipment:

1. Generally, SPD's shall employ Gas Discharge Tube (GDT) technology for the following reasons:

   a) GDT's have very low capacitance at very high frequency transmission lines (several GHz).
   b) Following an overvoltage incidence, the GDT will return to its original condition of high isolation and will become operational again. This occurs since the GDT is connected in parallel between the central conductor and the external shield of a coaxial type installation.
   c) The GDT's have a very wide bandwidth from DC to 6GHz.

2. "Quarter-Wave" SPD's shall be used as 'band-pass" filters to act as a short circuit between the conducting core and the external ground for the tuned frequencies. They filter out the lightning low-frequency spectrum from the operating frequencies.
3. Connector Types: N, TNC, SMA, F, BNC, etc. as required by the protected installation.

B. SPD's for outdoor use shall be suitable for the prevailing outdoor environmental conditions described in Division V, Section "Basic Electrical Materials and Methods".

C. Material:

1. Housing: Brass, with white bronze tri-metal alloy.
2. Contacts: Bronze with gold/silver plating.

D. SPD's shall be installed at the Service Entrance of the installation, to limit the propagation of lightning currents, and also near sensitive equipment.

E. Below Table shows characteristics of typical protection configurations of combined lightning protection and surge arresters that shall be required at Service Entrances ($LPZ0_A$-LPZ2 or higher). Final selected configuration shall be based on type of line to be protected, number of lines to be protected and type of installation in addition to the recommendations of the protected equipment manufacturer.

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Characteristic	Application		
	TETRA	Wireless LAN 5GHz Band	Analogue & Digital TV
Frequency Range	380-512MHz (1/4 wave technology)	2-6 GHz	DC, 5-2400 MHz
Maximum Continuous Operating DC Voltage (U_c)	0V	0V	24V
Nominal Current (I_L)	0A	0A	2A
Max. transmission capacity	3000W	300W	-
D1 Lightning impulse current (10/350 µs) (I_{imp})	25kA	25kA	2.5kA
C2 Nominal discharge current (8/20 µs) (I_n)	50kA	50kA	10kA
Voltage protection level for I_{imp} D1 (U_P)		≤ 18 V	≤ 230 V
Voltage protection level for I_n C2 (U_P)	≤ 130 V	≤ 30 V	≤ 300 V
Voltage protection level at 1 kV/µs C3 (U_p)	-	-	≤ 60 V
Insertion Loss	0.1dB	≤0.2dB	1.7dB (5-862MHz) 1.9dB (862-2400MHz)
Return Loss	≥20dB	≥20dB	≥14dB(8-47MHz) ≥18(47-2400MHz))
Surge Impedance	50 ohms	50 ohms	75 ohms

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division A Specification Sections, apply to this Section.

PART 3 PRODUCTS AND WORKMANSHIP

300.000 MATERIALS

300.010 MANUFACTURERS

A. Approved Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

1. ABB.
2. Eaton / Moeller
3. Eaton.
4. Emerson Electric.
5. GE Zenith Controls.
6. Leviton.
7. Siemens.
8. Dehn.
9. Furse.
10. Schneider Electric.
11. Lovato

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310.000 QUALITY MANAGEMENT

310.010 QUALITY ASSURANCE

A. Manufacturer Qualification: A firm regularly engaged in the manufacture of surge protective devices, of types and capacities required, and whose products have been in satisfactory use in similar service for not less than five years.

310.020 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, and handle materials, components, and equipment as per Manufacturer's instructions.

310.030 WARRANTY

A. Manufacturer's Warranty: Submit a written warranty signed by the manufacturer agreeing to repair, restore or replace any defective equipment specified in this section during the specified warranty period

   1. Warranty Period: 1 year from date of substantial completion.

320.000 SUBMITTALS

A. Product Data: For each type of product.

   1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
   2. Copy of type test certificate in accordance with IEC 61643.

B. Energy coordination study between SPDs installed at different levels.

C. Field quality-control reports.

D. Sample Warranty: For manufacturer's special warranty.

E. Maintenance Data: For SPDs to include in maintenance manuals and to the satisfaction of Employer's requirements.

330.000 EXECUTION

330.010 INSTALLATION

A. Comply with IEC 61643-11, IEC 61643-21 and BS 7671.

B. For equipment installed at the roof / outdoor, coordinate with the equipment manufacturer for surge protection requirements according to the recommendations of the equipment manufacturer.

C. Leads / wires shall be routed through the shortest straight parallel path. Wires shall be twisted type to reduce conductor's inductance.

D. Install SPDs such that the total SPD lead length(s) and size(s) along with the distance between the SPD and the protected equipment does not exceed the values required by IEC 60364-5-53 or recommended by manufacturer for proper operation whichever is more stringent.

E. Use crimped connectors and splices only. Wire nuts are unacceptable.

F. Tighten electrical connectors and terminals, including screws and bolts, according to manufacturer's published torque-tightening values and / or recommendations. If manufacturer's torque values are not indicated, use those specified in applicable Standards.

G. Wiring:

   1. Power Wiring: Comply with wiring methods in Division Y Section "Low-Voltage Electrical Power Conductors and Cables."
   2. Controls: Comply with wiring methods in Division Y Section "Low-Voltage Electrical Power Conductors and Cables."

H. Telecommunications and Signal Processing Equipment

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1. To be effective, surge protectors shall be installed in accordance with the following principles:
    a) The grounding point of the surge protector and that of the protected equipment shall be inter-connected.
    b) Protection shall be installed at the network entrance to divert impulse currents as fast as possible.
    c) The protected equipment shall be located near the surge protector (less than 10m). If this rule cannot be achieved, secondary protection shall be installed near the equipment for coordinated surge protection.
    d) The grounding conductor between the ground output of the protector and the installation bonding circuit shall be as short as possible (less than 50 cm) and shall have a cross-sectional area of at least 2.5 mm².
    e) The ground resistance shall comply with Project Specifications.
    f) Protected and unprotected wires shall be kept apart to limit the potential for coupling.
2. In an equipotential bonding network and to reduce the residual voltages during lightning discharge currents, the connection of Radio communications protector to the bonding network shall be as short as possible (less than 50 cm) and shall have a proper cross sectional area of at least 4 mm².

330.020 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.
    1. Compare equipment nameplate data for compliance with Drawings and Specifications.
    2. Inspect anchorage, alignment, grounding, and clearances.
    3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Prepare test and inspection reports.

330.030 STARTUP SERVICE

A. Complete startup checks according to manufacturer's written instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

330.040 DEMONSTRATION

A. Train Employer’s maintenance personnel to operate and maintain SPDs. Refer to Division A Section "Demonstration and Training and Closeout Procedures."

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W60 - CENTRAL CONTROL BUILDING MANAGEMENT

PART 3 SPECIFICATION CLAUSES SPECIFIC TO W60

300.000 GENERAL

300.002 DESIGN PARAMETERS AND PERFORMANCE OBJECTIVES:

- The Contractor shall supply, install, test and commission the Building Management System as detailed in this specifications, control diagrams, design drawings and applicable standards.
- The scope of works includes the supply, installation, testing and commissioning, start up of the BMS and training of the operators.
- The BMS shall use direct digital controllers (DDC) for controlling and monitoring the individual MEP systems.
- The Contractor must note that the Specification describes in general terms the control philosophy for various systems and the means of achieving the same. These are the minimum requirements only. In view of the rapid changes in the field of controls and related technology, the Contractor shall include for the latest technology and systems available from the specified manufacturer at the time of tender. The Contractor shall allow the costs related to loading the latest version of software available at the time of handing over of the installation.
- The Building Management System shall be a Client/server System consistent with latest industry standards operating on a fully open protocol that is widely recognized by many different BMS developers. It shall use simple operating techniques and shall be used to monitor and control building services installations. The Contractor is advised that the full and correct operation of the BMS installation is required and that he shall take all necessary measures to achieve this.
- The proposed system and components shall be compatible with a wide variety of control devices and third party systems using BACnet, Ethernet TCP/IP, Modbus and OPC standard for open system communications and other current international communication standards. The BMS shall be capable of being extended with controllers on the BACNET protocol. The BMS shall allow integrating future BACnet controllers on the management and on the automation levels.

300.003 SYSTEM DESCRIPTION AND REQUIREMENTS:

- The BMS shall be designed to utilize the building's IT network infrastructure, where this is installed and it is practical to do so. The BMS specialist shall, however, allow for integration and connection of all BMS functions and systems by independent systems as required to achieve the functionality of the BMS specified in this specification. The BMS communication backbone shall use BACNET.
- The current system architecture is based on having a dedicated BMS server that is integrated to the various systems within the overall development with BMS Outstation location as shown in BMS network schematic, contractor shall provide the number of BMS outstations as required for the project and not limited to the numbers represented on the schematics.
- The DCC control panels and enclosures shall be linked over the converged data network.
- All hard wired I/O points shall be connected to the above panels/controllers
- Select control components and equipment, suitable to meet system objective requirements. Ensure that system safety complies with:
    - BS EN 61508-series for control of systems where an assessed safety integrity level is required
    - BS EN ISO 13849 and BS EN ISO 13849-2 for safety-related components of control systems

    - BS EN ISO 13850 for design of emergency stop functions
    - BS EN 61511-1 for functional safety of programmable controllers
- Comply with BS EN 15500-1 for electronic individual zone control equipment.
- Comply with relevant parts of BS EN 60730 for automatic electric controls.
- Comply with the following standards for building automation and control systems (BACS) components:
    - BS EN ISO 16484-2 for hardware
    - BS EN ISO 16484-3 for functions
- Comply with the requirements of the relevant parts of BS EN 50491, BS EN 63044-1 and BS EN IEC 63044-3 appropriate to the project, for Home and Building Electronic Systems (HBES) and Building Automation and Control Systems (BACS).
- Refer to Part 4 of this specification section W60 and other relevant clauses of the Particular specification sections R, S, T, U, V and W. Refer to BMS schematics for sequence of operation and I/O point schedules.

300.020 CONTROL SYSTEM:

- Provide a Building Management System (BMS) to meet the particular requirements detailed in the system objectives, descriptions and control strategies.
- Provide a Building Management System, including:
    - Equipment design
    - Development of design
    - Supply
    - Installation
    - Commissioning
    - Setting to work
    - Operator training
    - Fine tuning and seasonal commissioning during the defects period
    - Integration with other systems as specified elsewhere within this specification

300.030 CONTROLS SPECIALIST:

- Use a controls specialist to design, supply, install, test and commission complete controls installation.

300.060 CONTROL COMPONENTS MANUFACTURER:

- Unless otherwise indicated use control components and equipment from one manufacturer throughout.

300.100 ELECTROMAGNETIC COMPATIBILITY:

- Ensure all monitoring system equipment is compatible and does not adversely affect any other equipment installed in the same location.
- Ensure all systems are designed and installed with due consideration to good electromagnetic compatibility (EMC) practice, and in line with EMC requirements of relevant standards including:
    - BS 7671 (IET Wiring Regulations)

- BS EN 50310 for earthing and bonding in relation to communications system components
- BS EN 50174-series for communications and control cabling
- BS EN 61000-6-7 and BS EN 61000-1-2 as relevant for EMC in relation to functional safety

- Ensure all equipment complies with BS EN 50130-4 where relevant.
- Ensure fire alarm interface equipment complies with BS EN 50130-4 where relevant.

310.020 GENERAL REQUIREMENTS - ELECTRICAL SAFETY:

- Ensure that the BMS installation complies with BS 7671.
- Ensure that control panels comply with:
  - Relevant parts of BS EN 61439-series.
  - BS EN 60204-1 where the control panel is classed as Machinery in accordance with the Supply of Machinery (Safety) Regulations 2008.

310.030 GENERAL REQUIREMENTS - ELECTRICAL SUPPLY:

- Ensure that the BMS can operate when supplied with electricity conforming to:
  - BS EN 50160 - voltage characteristics of electricity supplied by public distribution systems
  - Additional voltage drop within the consumer's electrical installation in accordance with BS 7671 (IET Wiring Regulations)

310.050 GENERAL REQUIREMENTS - EMERGENCY RESTORATION PROCEDURES:

- Ensure that the BMS fully restores all control and monitoring functions following an emergency shut down period.
- Time period for restoration of plant [5 minutes]
- Ensure that the start delay times can be adjusted according to the magnitude of the load.
- Ensure that the system restart does not cause unsafe operating states.

310.070 GENERAL REQUIREMENTS - TIME SYNCHRONISATION:

- Ensure that all time-dependent BMS components are time synchronised:
  - System synchronisation source:
    - BMS client device
    - BMS system servers

- Ensure the BMS system time synchronisation source maintains at least the following accuracy requirements:
  - Unsynchronised accuracy better than 0.2 s / day.
  - Synchronised accuracy better than 0.1 s with respect to the master synchronisation source.
- BMS system time synchronisation source's master time synchronisation method:
  - Manual
  - Local Area Network (LAN)
    - Network type
      - Wireless.

        - Wired.
    - Time protocol
        - Network Time Protocol (NTP)
            - NTP v2.
            - NTP v3.
            - NTP v4.
            - Unicast RFC1305.
            - Broadcast RFC1119.
        - Simple Network Time Protocol (SNTP)
            - SNTP v3.
            - SNTP v4.
            - Unicast RFC1305.
            - Broadcast RFC1119.
        - TIME protocol RFC868
            - UDP mode.
            - TCP mode.
        - Time servers
        - Global Positioning System (GPS)
- Ensure that the BMS can automatically handle daylight saving adjustments
- Ensure that the BMS can automatically accommodate time adjustments such as leap years and leap seconds.

310.080 GENERAL REQUIREMENTS - SYSTEM SECURITY:

- Standards
    - IET Code of Practice for Cyber Security in the Built Environment
- Provide, as a minimum, operator access for the following levels based on user's login credentials:
    - Level 1 - Ability to display all point data
    - Level 2 - Ability to display all point data and to initiate data logging functions
    - Level 3 - Ability to display all point data; to initiate data logging functions; and to change set points and time schedules
    - Level 4 - Ability to display all point data; to initiate data logging functions; to change set points and time schedules; and to change control strategies and schematic/graphics functions and password assignment
- Ensure that appropriate credential-based operator and maintenance technician access is set up for clients, servers and field controllers
    - Login access type (field controllers):
        - Password
    - Login access type and complexity for operator clients and servers:
        - In accordance with information technology (IT) strategy
- Ensure that the BMS software is protected from unauthorised entry.

- Manage information security of systems, software and data during design, implementation and commissioning in line with BS EN ISO/IEC 27001.
- Ensure that the BMS can be maintained by a service provider in accordance with BS EN ISO/IEC 27001 and BS ISO/IEC 20000-1.

310.090 GENERAL REQUIREMENTS - SYSTEM SOFTWARE:

- Obtain on behalf of the end users all appropriate licences, permissions, copyright waivers, rights of use and the like from the owners of the software rights. Ensure that the end user is properly registered with the software supplier for support and appropriate updating. Provide documentation for application software in accordance with BS ISO/IEC 26513 and BS ISO/IEC 26514.
- Ensure that, as far as practicable, all software is commercially available off-the-shelf.
- Ensure that any programmable configuration, customisation and bespoke software is developed, tested and commissioned using relevant processes and procedures complying with BS ISO/IEC 12207 or BS ISO/IEC/IEEE 15288, supported by a quality management system meeting the requirements of BS EN ISO 9001.
- Ensure that IT industry standard operating systems are used.
- Ensure that copies of all BMS vendor-specific software are held by an independent third party and that this software can be released to the client.
- Ensure that the ESCROW Agreement is completed and signed.

310.093 GENERAL REQUIREMENTS - CHOICE OF CONTROL STRATEGY:

- Ensure that the selected control strategies are appropriate for the building services systems and their intended application.
- Ensure that selected control strategies are robust and not over complex.
- Where a novel control strategy is to be implemented, ensure that testing/evaluation is performed to confirm its suitability.
- Ensure that wherever possible selected control strategies are those provided in the BSRIA Library of System Control Strategies: AG 7/98.

310.095 GENERAL REQUIREMENTS - DESIGN FOR COMMISSIONABILITY:

- Ensure that the BMS specification details required for commissioning are made available to the BMS commissioning engineer.
- Ensure that all field controllers, sensors and controlled devices are easily accessible and can be removed for testing and future maintenance.
- Liaise with the mechanical contractor to ensure that air handling units are provided with appropriate access doors.
- Ensure that access is available to all control devices. Comply as appropriate with:
    - BS EN 547-series
    - BS 7671 (IET Wiring Regulations) requirements for maintenance gangways
- Ensure that the requirements of the following documents are met:
- Ensure that sensors are installed correctly in order to give representative readings.
- Ensure that reference labels are attached to each control device.

310.096 GENERAL REQUIREMENTS - FUTURE SYSTEM EXPANSION:

- Ensure that the BMS is capable of dealing with a future 20% increase in the number of points without compromising the system's functionality or speed of operation.

310.097 GENERAL REQUIREMENTS - DESIGN FOR MAINTAINABILITY:

- Ensure that a full O&M manual is prepared which reflects any system changes made during the installation and commissioning stages.
- Ensure that adequate access to BMS equipment and components is provided.
- Ensure that all components and wiring are identified by a consistent numbering system.

310.100 GENERAL REQUIREMENTS - SYSTEM SUPPORT:

- Ensure that a viable strategy is in place to fully support the BMS for a minimum of 10 years from the date of practical completion.

310.110 OPERATOR CLIENT / SERVER - OPERATIONAL CHARACTERISTICS:

- Ensure that the control of plant is independent of the operator workstation.
- Ensure that no data of a control nature is transferred between field controllers via the client / server, i.e. data relating to control strategies.
- Ensure that the client / server can communicate with all addressable field devices.
- Provide complete system integrity such that the network of field controllers will continue to fully operate following a failure of the client / server.
- Ensure that the appropriate control strategy configuration data can be downloaded to all addressable field devices.
- Provide a means of displaying and modifying each addressable field controller's control strategy, time schedules and set-points via the client / server.
- Allow the operator to re-schedule plant operation times. Ensure that re-scheduling can be applied globally to a number of items of plant at one or more sites (or one or more controllers on one site) as selected by the operator.
- Allow an operator with sufficient user privileges (e.g. Administrator access) to create, modify and delete control strategies within all addressable field controllers.
- Ensure that the client / server incorporates a data storage management system that warns against impending online storage overflow and allows for data archiving to, and retrieval from, offline non-volatile media. Ensure that the operator is prompted at pre-defined intervals to carry out the data archiving procedure.
- Ensure that it is possible to perform a complete backup of the Plant control strategies, set-points and logged data to the server.
- Where neither network-attached storage (NAS) storage area network (SAN) or cloud storage are utilised to backup purposes by the system, provide an electronic data archival device that uses readily available non-volatile media that is appropriate for long term storage of system software, configuration data and logged data (including alarm data).
- Allow the transfer of data from the system memory and other storage devices to the archive mediums, and vice versa for the preparation of reports.
- Ensure that the system can be fully restored from backup data.

310.115 BMS SERVER EQUIPMENT:

- Type, 19” Rack mounted server
- Standard
    - BS EN ISO 16484-3
    - BS EN 60950-1
    - BS EN 62368-1
- Approach

- Virtual server shall be used when more than one physical server is required. The virtual environment shall be implemented on the physical servers.
- Physical server (s)
- Location as indicated in the design drawings
- Duty-standby server
    - Type
        - Hot standby.
- Local storage
- Hard disk
- Capacity (GB) 2000

- RAM (GB) 32
- Processor
    - Ensure that the processor speed is such that delays in processing system data do not exceed 500 mseconds
- Administrator interface
    - Remote desktop
    - Local user interface
        - Rack drawer Monitor KVM
            - UK QWERTY keyboard with touchpad
            - Monitor size 19”
            - Monitor resolution FHD 1080p

- Operational and maintenance user interfaces:
    - Concurrent users at least 10
    - Client application
        - Laptop.
        - Desktop through thin client (web browser access)

310.120 CLIENT DISPLAY EQUIPMENT:

- Standard
    - BS EN ISO 16484-2
    - BS EN 60950-1
    - BS EN 62368-1
- Client
    - Personal computer.
    - Laptop.
    - Local disk
        - Solid state disk for operating system
        - Hard disk for working data
        - Capacity (GB) 1
    - RAM (GB) 16

- Processor
    - Ensure that the processor speed of each client meets the data processing requirements.
    - Ensure that the processor speed is such that delays in processing system data do not exceed 500 mseconds
- Monitor / display
    - Type
        - Separate monitor.
        - Built-in to client device.
    - Use a colour display with a resolution no less than 1080p
    - Diagonal dimension of the monitor 25”
    - Protection against reflection
- User access
    - Provide a UK QWERTY keyboard with full upper/lower case ASCII key-set, numeric keys and mouse

310.125 PRINTER:

- Type, Laser
- Standard
    - BS EN 60950-1
    - BS EN 62368-1
- Ensure that the printer can print all monitored and logged data (including graphs of logged data); all point data (hard and soft); control logic and plant/building schematics in colour; alarm data/text; and system help text.
- Ensure that the automatic printing of alarm data can be switched on/off.
- Ensure that alarm data can be routed to specific clients and/or individual operators as identified by their specific logon information.
- Ensure that the printer has a minimum output of four pages per minute.

310.130 SYSTEM MONITORING AND LOGGING FUNCTIONS:

- Ensure that all monitored point data can be displayed at the client. Ensure that analogue, digital and soft-points can be displayed simultaneously.
- Ensure that all changes made by the operator (e.g. set-point changes) can be logged and identified by both operator and date/time stamp.
- Provide a facility to allow the display, at the client, of 'real time' data superimposed on plant schematics and refreshed automatically as the monitored value changes.
- Ensure that a minimum of six 'real time' data points can be displayed simultaneously, on one graph, in the form of data plots.
- Provide a facility to allow the monitoring and display, on the same 'page', of common criteria/plant functions.
- Ensure that any hard or soft-point log can be displayed and stored on any operator workstation.
- Ensure that logs can be set up from any client and that optional logging start and stop dates and times are adjustable.
- Ensure that log samples can be recorded either on a polled basis, where the logging intervals are user adjustable between 1 second and 24 hours, or when the value changes by an amount greater than an adjustable hysteresis threshold.

- Ensure that the server has sufficient data storage capacity to accommodate the defined amount of logged data and that the data can be backed up.
    - Amount of logged data: 2 years
- Provide a facility to allow the simultaneous display of different logged data. Ensure that this function is operator adjustable.
- Provide a facility to allow the export of logged data to other software packages. Ensure that the format of the exported data can be fully defined

310.140 GRAPHICAL USER INTERFACES:

- Standard
    - BS EN 61082-1 for general schematic and information presentation
    - BS EN 60073 for indications and actuator states
    - ISO 7000 / IEC 60417-series, IEC 60617 and ISO 14617-series for symbols in general
    - BS 1553-1 for piping systems and plant symbols and schematics
    - BS 1553-2 for power generating plant symbols and schematics
    - BS 1553-3 for compressing plant symbols and schematics
    - BS 1635 for fire protection system symbols and schematics
    - BS 4737-5.2 for the intruder alarm system symbols and schematics
    - BS EN 1861 for refrigerating system and heat pump symbols and schematics
- Provide a library of plant schematics and symbols, the format/contents of which should be confirmed with the specifier based on samples.
- Provide a facility to allow the operator to generate additional schematics and symbols using readily available drawing formats (e.g. bitmap, jpeg).
- Ensure that the system can accommodate the addition of 20% extra graphics 'pages'.
- Provide an easy to use facility to allow the operator to modify plant schematics and to generate new ones. New elements for schematics to be available on a Tool Palette, and the association with data points in controller outstations to be made using drag-and-drop.
- Ensure that graphics can be displayed in a layered approach (building layout graphics down to plant subsystems and components). Ensure that the operator can modify the structure of the layered approach.

310.150 USER INTERFACE - HELP AND ASSISTANCE:

- Provide a facility to allow the display of help text covering all operator functions and system fault conditions.
- Provide a facility to allow the display (including a hard copy) of points list (hard and soft-points) and control strategy.

310.160 INTEGRATION WITH THIRD PARTY MANAGEMENT SOFTWARE:

- Energy monitoring and targeting software
    - Provide a facility to allow the direct transfer of recorded energy consumption and external air temperature readings from the BMS to the monitoring and targeting software. Ensure that real time data is available in a standard database format (e.g. SQL, ODBC, etc).
- Maintenance management software

- Provide a facility to allow the direct transfer between the BMS and the maintenance management software of plant run hours; number and frequency of plant starts; critical alarms requiring immediate attention; and maintenance (non-critical) alarms.
- Ensure that real time data is available in a standard database format (e.g. SQL, ODBC, etc).

310.170 SYSTEM ALARMS:

- Standard
  - BS EN 62682
  - Engineering Equipment and Materials User Association publication No.191 "Alarm systems: A guide to design, management and procurement"
- Ensure that alarms are displayed on a rolling basis in chronological order.
- Ensure that the operator can acknowledge alarms, including muting of audible or flashing annunciators.
- Provide a facility to silence audible alarms or inhibit flashing annunciators without performing alarm acknowledgement.
- Ensure that alarms can be inhibited for reasons of time and/or priority as selected by the operator.
- Ensure that the BMS can be configured to avoid fleeting alarms, i.e. ensure that alarms can accommodate start-up and shutdown delays.
- Ensure that the administrator can alter the limits at which the measured values cause alarms to be triggered.
- Ensure that alarms can be limited to the source items(s) of plant.
- Ensure that alarm limits can accommodate sliding limits, e.g. set-point changes.
- Ensure that alarms can be differentiated by means of alarm type and identification.
- Ensure that alarms can be prioritised (including a high priority that will be annunciated regardless of other activity) and a low priority or information status that is only annunciated on demand.
- Ensure that the time taken to receive alarms does not exceed 2 seconds
- Ensure that visual, audible and printed annunciation of alarms, or any combination of these, can be selected by the operator.
- Ensure that the reception and acknowledgement of alarms can take precedence over other operations. However, ensure that the reception of alarms does not hinder user log-in.
- Allow the user to acknowledge alarms individually and on a group basis. Acknowledgement should include muting or flashing annunciators.
- Provide distinction between active alarms whose conditions are not cleared and unacknowledged alarms.
- Provide an alarm-latching facility with manual reset.
- Ensure that alarm data provides condition identity; condition value; alarm source; alarm time and date; and acknowledgement status.
- Ensure that the alarm file can be sorted by the above criteria.
- Allow alarms to be automatically redirected to other operator workstation or to individual operators, regardless of which workstation they are logged on to.
- Provide sufficient data storage capability for the storage of alarms.
- Ensure that any stored alarm data can be analysed in conjunction with other monitored conditions or stored logged data.
- Ensure that an alarm review facility is available.
- Allow the display of stored alarm data based on user definable selection criteria.
- Ensure that the operator can define the requirement for acknowledgement of alarms; a time programme for annunciation of alarms to different destinations; and text messages associated with alarm conditions.

- Ensure that critical alarms can be relayed by SMS text message and/or email to a distribution list of operators. The definition of a 'critical alarm' is to be wholly adjustable by the administrator.

310.175 FIELD CONTROLLERS - GENERAL:

- Type, Direct Digital Controller BTL Listed B-AAC, B-ASC
  - B-AAC
    - Controller shall be 32 bit microprocessor based BACnet® Advanced Application Controller.
    - The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signals.
    - All Advanced Application Controller shall be fully programmable with the help of Windows based software programming tool and shall at all times maintain their BACnet® compliance.
    - All control sequences within or programmed into the B-AAC shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.
  - B-ASC
    - Controller shall be 32 bit microprocessor based BACnet® Application Specific Controller.
    - The application control program shall be resident within the same enclosure as the input/output circuitry, which translates the sensor signal.
    - Mains powered ASCs serving FCUs shall have provide 24 VAC output that serves to power the modulating valve actuator.
- Application
  - B-AAC: HVAC plants control such as Air Handling Equipment
  - B-ASC: Terminal Unit Controllers
- Standard
  - BS EN ISO 16484-2
  - BS EN 15500-1
- Mounting
  - In control panel
- Casing material
  - Rigid plastic.
  - Rigid plastic with die cast aluminum finish.
  - DIN rail mount

310.180 FIELD CONTROLLERS - MODES OF OPERATION:

- All field controllers shall be direct digital controllers (DDCs).
- Ensure that the field controllers perform all control actions independently of the HMI.
- Ensure that the field controllers perform all control actions independently of the operator workstation.
- Ensure that all field controllers can operate independently and in real time following a failure of the BMS communication network.

- Ensure that field controllers can operate with the loss of shared data through the use of default values and final data reading before the loss of network communications.

310.190 FIELD CONTROLLERS - PHYSICAL CONSTRUCTION:

- For internal plant room applications, construct field controller enclosures to give a minimum degree of protection to IP54 in accordance with BS EN 60529. Where the field controller is fitted inside a control panel that is protected to IP54 then the field controller protection can be reduced to IP41. For external applications, construct field controller enclosures to IP65.
- Where an enclosure is to be provided ensure that field controller enclosures are lockable.
- Ensure that modular construction is used for field controllers. Ensure that this allows the removal and replacement of devices without the need for rewiring of field wiring.
- Ensure that I/O modules can be removed and replaced without the need to power down the entire modular system (i.e. I/O modules are hot-swappable).

310.200 FIELD CONTROLLERS - TERMINATIONS:

- Use terminals of the screw down clamp-type fixed to purpose made mountings.
- Segregate into groups terminals of different voltage bands (in accordance with BS 7671).

310.210 FIELD CONTROLLERS - FUTURE EXPANSION:

- Make provision for a future 20% increase.

310.220 FIELD CONTROLLERS - CONTROLLER INPUTS:

- Ensure that the interfaces for the field controllers are appropriate for gathering data from sensors and devices. Ensure that the following requirements are met.
- Universal inputs
    - Variable currents (4-20 mA), variable voltages (0-10V), variable resistances or volt-free contacts.
    - Ensure that the scaling tables, necessary to process inputs configured as type analogue, are resident at the field controller.
    - Ensure that a minimum and maximum limit value can be defined for each analogue input.
    - Ensure that each limit is associated with a configured response.
    - Ensure that the field controller can detect open or closed circuit faults and raise an alarm on the operator workstation.
    - Ensure that the configuration tables necessary to process inputs configured as type digital are resident at the field controller.
    - Ensure that the configuration tables necessary to process inputs configured as type multi-state are resident at the field controller.
- Pulsed inputs
    - As derived from volt-free contacts (max 24 volts/20mA) at a pulse frequency of up to 200 Hz.
    - Ensure that the routines necessary to process pulsed inputs are resident at the field controller.
    - Ensure that the field controller has the following capabilities:
        - Storage of cumulative totals daily; weekly; monthly; yearly; and continuously
        - Operator re-set facility of cumulative totals via the operator workstation
        - Ability to re-set the cumulative totals via control strategy as required
        - Ability to use and manipulate pulsed input data within the control strategy

        - Alarm facility based on a user-defined limit being exceeded
    - Ensure that the inputs which are used to monitor fluctuating pulse rate (e.g. maximum demand meter for electricity) have operator adjustable limits.
    - Ensure that when data for pulsed inputs is recorded, the record includes both the pulse count and logging intervals for cumulative counts.
- Run-time totals
    - Include run-time totalling routines to enable the operator to record cumulative run-time for each item of plant selected.
    - Provide the operator with the option to set a different maximum run-time for each item of plant selected.
    - Ensure that when the maximum run-time has been reached an alarm is signalled to the operator.
    - Ensure that the operator workstation can be used to interrogate field controllers for a point-by- point summary of run-time totals and run-time limits.
    - Ensure that it is possible for the user to set an initial value of hours run other than zero.
    - Ability to re-set the value of hours run to zero, or other value, via the control strategy.
- General
    - Ensure that all inputs can be scanned at intervals not exceeding 0.25 seconds.
    - For time-critical control applications, ensure that the field controller can scan at a time interval not exceeding 100 mseconds
    - Ensure that all inputs are protected against spurious out-of-range signals including those caused by contact noise or bounce.
    - Ensure that errors introduced by the analogue to digital conversion of inputs do not exceed 1 LBS.

310.230 FIELD CONTROLLERS - CONTROLLER OUTPUTS:

- Ensure that isolation between controllers and networks meet the requirements of BS EN 63044-series.
- Ensure that the field controllers' interfaces are capable of providing control signals to actuators and switching devices.
- Ensure that routines are configurable, such that one or more events may be enabled in direct response to any defined logical relationship between the status of a number of physical or soft-points.
- Ensure that in the event of power failure, output devices can be driven to their preset, fully open/closed position.
- Provide the following interface characteristics:
    - Analogue output. As variable currents (4-20mA) or as variable voltages (0-10V). Ensure that it is possible to characterise analogue outputs in order to obtain a near linear response from the controlled items of plant.
    - Digital output. Ensure that digital outputs can be selected as 'normally closed' or 'normally open'.
- Ensure that errors introduced by the digital to analogue conversion of outputs do not exceed 1 LSB.
- Ensure that the field controller is capable of receiving feedback signals which allow the comparison between an output signal to a controlled device and its actual condition.

310.240 FIELD CONTROLLERS - POSITIVE FEEDBACK:

- Ensure that the field controllers can include routines necessary to confirm that specific items of plant are functioning correctly. Ensure that this can be performed by monitoring physically separate but functionally related sensors, switches or transducers.
- Ensure that an alarm is raised if the expected response has not been established by a pre-set time following switching on of plant. Ensure that it is possible to operate any specified standby plant. Provide the operator with a facility to adjust the pre-set time delay.
- Ensure that the field controllers are capable of using measured feedback from an actuator position to give a percentage open reading.

310.250 FIELD CONTROLLERS - DATA MONITORING AND LOGGING:

- Ensure that hard and soft-points associated with a field controller can be logged.
- Ensure that the BMS operator can set the start/stop dates and times at the operator workstation.
- Ensure that the BMS operator can choose between polled logging, with a defined interval, and event logging, where the monitored point is logged when it changes state (for digital and multistate points), or changes value by more than a defined amount (hysteresis) in the case of analogue points.
- Ensure that logging is selectable between a finite memory buffer or on a rolling basis.
- Ensure that each log can be defined in terms of log identification (point identification); units; and date/time stamp.
- Ensure that the operator can select all physical and soft-points for logging.
- Ensure that the field controller has sufficient memory to log the equivalent of seven days data at 15 minute intervals for 50% of the total number of physical points on the field controller.
- Ensure that the log data is to be automatically uploaded to the operator workstation / system server and stored in a standard database format (e.g. SQL, ODBC).

310.260 FIELD CONTROLLERS - ENVIRONMENTAL CONDITIONS:

- Ensure that field controllers are suitable for operating normally within the following environmental ranges:
  - Temperature 0 to 55°C
  - Relative humidity 10% to 90% non-condensing
- Ensure that the field controllers will operate in the electrical environment associated with building services plant rooms.
- Ensure that the field controllers are protected against the effects of moisture, dust, dirt and gases.

310.270 FIELD CONTROLLERS - INTERNAL POWER BACKUP:

- Ensure that a rechargeable battery or capacitor, if specified, can hold the controller's volatile memory for a minimum period of 72 hours.
- Ensure that a non-rechargeable battery or capacitor, if specified, can maintain the controller's clock function for a period of two years.
- Ensure that the battery is easily replaceable and raises an alarm on the BMS when battery failure occurs.
- Ensure that the interval between battery maintenance inspections is not less than 12 months.
- Ensure that any battery monitoring functions defined in the Particular Inspection can be met.

310.280 FIELD CONTROLLERS - MEANS OF CONFIGURATION:

- Ensure that the field controllers can be fully configured directly via a laptop type computer and via the operator workstation and BMS servers.

- Ensure that the field controllers can be configured through the use of a configuration interface with full upload and download capability.
- Ensure that configuration details can be easily altered by system operators.
- Ensure that access to make configuration alterations is restricted to operators with access authority through the use of passwords.
- Ensure that field controllers are supplied with a service port that allows connection of wired and Bluetooth wireless devices for configuration via a laptop type computer.
- When connected using the service port, all the controllers in the entire BMS network are to be accessible via the laptop type computer.

310.290 FIELD CONTROLLERS - USER INTERFACES:

- Ensure that all field controllers can be accessed through the use of portable computers.
- Ensure that access allows the display of all configuration details associated with the field controller along with:
    - Password protection for access with a minimum of two access levels
    - Ability to display all point data (both hard and soft)
    - Ability to initiate and display logged data
    - Ability to display and alter set-points and time schedules
    - Ability to make alterations to control strategies
- Ensure that one field controllers for each plant room incorporates a panel-mounted operator interface. Ensure that the interface includes the ability to:
    - Provide password protection for access with a minimum of two access levels
    - Display graphical representations of plant schematics in full colour
    - Display all physical point data
    - Display and alter set-points and time schedules
    - Display the current date and time
    - Review and acknowledge alarms
    - Display logged data in graphical format, with overlaying of up to 8 logs on a single graph.

310.300 OCCUPANT CONTROLS - GENERAL:

- Ensure that the specified occupant controls can be linked to, and communicate over, the BMS communications network.
- Ensure that the occupant controls can control the relevant items of plant.
- Ensure that the status of each occupant controller can be viewed and overridden via the operator workstation.
- Ensure that each occupant controller has a service port available that allows a laptop type computer to be connected using a suitable wired service tool. It shall be possible to disable the service port function via the password protected configuration settings for the occupant control.
- When connected using the service port all controllers in the entire BMS network are to be accessible via the laptop type computer.
- Ensure that the occupant controls allow:
    - Adjustment by the occupants of the set-points
    - Definition, and adjustment by the BMS operator, of high and low limits for each set-point control
- Provide a facility to allow the global alteration of set-point and high/low limits via the operator workstation.
- Provide an override facility to allow plant operation during out of hours occupation.
- Ensure that the occupant controls are intuitive to use and clearly labelled.

- For temperature control ensure that hot/cold and/or red/blue indication is used for the occupant interface.
- For fan speed control ensure that fan fast/slow indicators are used.
- Ensure the +/- symbols are not used without clarification of the controlled function.

310.310 NETWORK CONTROLLER - GENERAL:

- Type, Network Controller or Building Controller BTL Listed B-BC
    - The Network Controller (NC) shall be a Native BACnet® controller based on 32 bit technology to provide the interface between the field control network and the BMS management level and provide global supervisory control functions over the control devices connected to the NC.
    - The NC shall conform to BACnet® Building Controller (B-BC) profile and shall have at least two (2) TIA/EIA-485 ports configurable for BACnet MS/TP, Modbus, etc.
    - The NC shall be provided with appropriate PIC statement defining BACnet® services and objects supported. BACnet® Data Sharing BIBBs supported shall include at a minimum: RP, RPM, WP, WPM and COV. Alarm and Event, Trending, and scheduling including SCHED-A BIBBs support shall also be supported in BACnet® native communications.
    - The NC shall support Master Communication control on the BACnet communication bus and shall physically connect to the LAN without the need for additional Router hardware
    - The NC shall support transmitting and receiving segmented messages as well as BACnet® Broadcast Messages over IP.
    - It should be possible to define any NC / GPC in an IP subnet as a BBMD device.
    - The NC shall also support both Secure (https://) and non secure (http://) remote web server access using commonly used web browsers. It shall be capable of executing application control programs to provide as shown on the drawing provide 32 bit bacnet controllers with BACnet communication: according to ISO 16484-5 and B-BC (BACnet - building controller) profile. Data communication shall be achieved utilizing:
        - Calendar functions
        - Scheduling
        - Trending and Trending Backfill
        - Alarm monitoring and routing
        - Time synchronization
        - Integration of BACnet® devices and BACnet® controller data
        - Integration of MODBUS devices and serial MODBUS RTU controller data.

310.330 CONTROL FUNCTIONS AND ROUTINES - GENERAL:

- Provide a facility to automatically cycle selected actuators through their full range of movement outside normal operating periods in a sequential manner with a periodicity set by the operator (in addition to normal automatic or manual control). Ensure that the cycle finishes as one complete operation. Ensure that any alarm conditions raised during the operation are inhibited as necessary.
- Provide a facility to drive actuators to their open or closed positions at the end of plant operating periods.

310.340 CONTROL FUNCTIONS AND ROUTINES - BASIC CONTROL FUNCTIONS:

- Ensure that configuration routines necessary for direct digital control (DDC) are resident at the field controllers.

- Provide DDC of plant through algorithms giving proportional plus integral plus derivative control (PID).
- Provide two-position control.
- Provide raise-lower or three-point control.
- Allow the selection of either proportional control (P), or Integral only control (I), or proportional and integral control (P+I) or proportional and integral plus derivative control (P+I+D) modes independently for each relevant item of plant. Ensure that proportional, integral and derivative action times can be adjusted by the user.
- Allow the combination of more than one control loop by 'cascading', i.e. using the output signal from one control loop as the input signal to another control loop.
- Ensure control routines provide for bumpless transfer capability when switching from manual mode to automatic mode.
- Ensure that the control routines are capable of controlling the individual plant items listed
- Provide a comprehensive programmable facility using a simple and easy to use program strategy tool that allows comprehensive debugging and live editing of control strategies.
- If a comprehensive programmable facility is not available then a micro function block based tool may be supplied providing the following requirements are met:
    - Provide logic modules covering:
        - Logical combination of digital variables
        - Logic timer module
        - Logic readback module
        - Logic counter module
        - Logic delay module
        - Logic hours run module
    - Provide the following logic functions:
        - AND
        - NOT AND (NAND)
        - NOT OR (NOR)
        - OR
    - Provide the following function modules as a minimum:
        - Filter (applies exponential filter with gain to input signal)
        - Rescale from (rescale an input of 0 to 100 to a user defined output and limits at these values)
        - Rescale to (rescales the input to the output of 0 to 100 and limits at 0 and 100)
        - Limit at (limits the output at user specified values)
        - Limit to (limits the output to 0 or 100 percent at values specified by the user)
        - Logarithm of input; Square root of input; Add to input; Multiply by input; Divide by input
        - Minimum (to select the minimum value from two or more inputs)
        - Maximum (to select the maximum value from two or more inputs)
        - Average (to calculate the average value from two or more inputs)
        - Analogue gate (digital signal switches output between two analogue input signals)
        - Comparator (to compare two inputs, when input X is greater than input Y output of one is produced otherwise the output is zero)
        - Enthalpy (to calculate the enthalpy value from a temperature input and humidity input)
        - Hysteresis (changes a digital state if the input changes outside a defined band)
        - Analogue to digital converter (to change analogue value to binary)
    - Provide comprehensive debugging and live editing of control strategies

- Ensure that the program strategy tool (whether comprehensive or Macro function block based) is not restricted to the use of the systems integrator but is available for suitable trained administrators via the operator workstation.

310.350 CONTROL FUNCTIONS AND ROUTINES - CONTROL INTERLOCKS:

- General
  - Ensure that the BMS is capable of providing all control interlocks
- Frost protection
  - Provide frost protection routines to operate plant and pumps in order to protect building services systems and their components from frost damage
  - Provide the following two stages of protection:
    - Ensure that when the outside temperature falls to the operator set minimum frost-protection temperature, the selected pumps start and circulation is established through pipework systems and their components. Allow the operator to pre-select which plant is to be started. The automatic standby plant is to operate on failure of the duty plant.
    - Ensure that when the return temperature falls below the operator pre-set minimum, the full frost-protection facility is initiated. Ensure that for heating systems, the heat source is turned on and operated to maintain the return flow temperature above the pre-set minimum. Ensure that specified protective devices activate for other liquid systems.
  - Provide a facility to allow frost protection to be logged together with data and time.
- Building/plant protection
  - Provide protection routines to operate the plant in order to protect the building fabric and its contents against the effects of low internal temperatures and of condensation.
  - Ensure that if the internal air temperature falls below the pre-set protection temperature, the heating system and related plant is turned on and heat supplied to maintain the air temperature at or above the protection set-point temperature.
  - Ensure that the building/plant protection routine overrides other control functions unless otherwise specified.
  - Ensure that protection operates whenever the normal heating is switched off.
- Safety interlocks
  - Ensure that all safety interlocks are hardwired and have precedence over all other control functions.
  - Ensure that safety interlocks can only be reset manually and locally (not from the operator workstation).
  - Ensure that all hardwired safety interlocks have corresponding software interlocks to prevent cascading nuisance alarms.
  - Ensure safety interlocks operate when plant selector switches are in 'Hand' or 'Auto' mode.
  - Ensure safety interlocks operate when frequency inverters are selected in 'Local' or 'Auto' mode at the inverter keypad.
  - Ensure safety interlocks comply as appropriate with:
    - BS EN 61508-series for control of systems where an assessed safety integrity level is required
    - BS EN ISO 13850 for design of emergency stop functions

310.360 CONTROL FUNCTIONS AND ROUTINES - TIME SCHEDULES:

- Ensure that each field controller is capable of enabling plant according to multiple pre-set time programmes. Ensure that it is possible to schedule each item of plant for a minimum of six separate switching periods per 24 hours. Ensure that separate schedules can be defined for each day of the week.
- Ensure that individual time schedules can be grouped to form global time schedules.
- Ensure that time schedules can be defined on a weekly basis on a single 'page/screen'.
- Ensure that time schedules can be defined 12 months in advance.
- Provide a time schedule override facility to accommodate holiday periods, etc.
- Allow fixed extensions and contractions to time schedules. Ensure that the time schedule reverts to the 'normal' switching periods following the extension/contraction period.
- Allow time schedules to be copied from existing schedules.
- Ensure that time schedules can be linked to optimum start/stop control facilities.
- Provide an optimum start/stop override facility for user-defined override days. Ensure that optimum start/stop control is enabled following the override period.
- Provide automatic switching between BST and GMT and back. Provide an operator override facility.
- Ensure that time schedules can accommodate leap years.

310.370 CONTROL FUNCTIONS AND ROUTINES - PLANT START/STOP CONTROL:

- Ensure that controllers are capable of starting and stopping plant according to the sequences detailed in the design drawings
    - Including any specific requirements for 'off' position or status of plant items, valves and dampers, etc.
- Ensure that controllers are capable of automatically enabling standby plant on failure of duty plant.
- Ensure that the controllers can automatically report plant failure alarms at the operator workstation.
- Ensure that the failure of a flow switch or other device does not continuously cycle plant.
- Ensure that if a flow switch fails the operator has the option to force either the duty or standby plant to come on.
- Provide the operator with the option to override any start/stop action configured within the controllers. When reverting to normal automatic control, ensure that the original program is automatically reinstated and updated to the correct time.
- Provide delayed plant-starting facilities in order to reduce power surges. Ensure that it is possible to start plant sequentially by adjusting the delay period for each item of plant.
- Ensure that delayed plant-starting occurs following power failure/re-instatement and plant shut down/restart on fire/fireman override.
- Provide the operator with a facility to specify minimum on/off cycle times and/or the maximum number of starts per hour for specified items of plant.
- Ensure that plant protection algorithms are included that define minimum on and minimum off times to prevent damage to items of mechanical plant that may be caused by rapid cycling, whether by faulty control strategy or by manual override.
- Provide a plant protection routine that enables the operator to select and automatically run items of plant for short periods during out of season shut-down. Ensure that the run periods are operator adjustable.
- Provide a routine whereby non-critical items of plant can be disconnected for short periods of time when approaching electrical maximum demand limits, without compromising environmental control.

310.380 CONTROL FUNCTIONS AND ROUTINES - SEQUENCE CONTROL:

- Provide sequence control routines to automatically sequence the operation of multiple items of plant by monitoring load parameters and efficiently matching the plant to the load.
- Ensure that it is possible to define different automatic sequences of control.
- Provide the operator with a facility to override the automatic sequence and define an alternative sequence.
- Ensure that the set-point values for each control action are variable and adjustable by the operator. Ensure that associated alarm limits are modified automatically.
- Allow the operator to adjust switching control differentials to prevent short cycling.
- Ensure that the routines also include a facility to operate all plant ancillaries associated with sequence control unless they have been specifically excluded.
- Ensure that the routines include the facility to proceed with the defined sequence when one of the items of plant in the sequence is isolated or fails to operate (unless the safety requirements dictate otherwise). Ensure that failed items of plant are removed from the sequence.

310.390 CONTROL FUNCTIONS AND ROUTINES - PLANT ROTATION CONTROL:

- Ensure that relevant field controllers are capable of alternating the lead plant items where duty and standby equipment is installed. Ensure that this is achieved both by an operator command and on a time-scheduled basis.
- Ensure that the rotation control can be provided on the basis of run hours, elapsed time and calendar basis.
- Provide routines to ensure that when the maximum number of start/stop cycles for a particular plant is reached, then its schedule is automatically modified, e.g. by rotating the standby equipment or changing the lead machine.
- Ensure that each item of plant operated under rotation control can operate at any stage of the rotation sequence
    - 1-2-3.
    - 2-1-3.
    - 3-2-1.
- Ensure that the plant rotation control can accommodate a plant failure condition, in such a way that a failed item of plant is 'replaced' by the next in the rotation cycle. Ensure that an alarm condition is raised in response to plant failure.
- Ensure that rotation control can be initiated outside normal operating periods.

310.400 CONTROL FUNCTIONS AND ROUTINES - OPTIMUM START/STOP FOR HEATING SYSTEMS:

- Provide an optimum-start routine for the heating system to compute the daily minimum preheat period necessary to achieve target comfort conditions at the start of occupation. Provide an optimum-stop routine to compute the earliest time for the heat source to be shut down in order to retain minimum target comfort conditions in the zone at the end of occupation.
- Ensure that the optimum start/stop routines have access to the system real time clock, calendar facility and time programme to define the occupation periods.
- Ensure that it is possible to apply optimum start/stop control both to individual zones and overall plant operation.
- Ensure that the routines operate the heating and ventilation plant as necessary to achieve the required target conditions, and that the heating and cooling systems do not conflict in any controlled zone.
- Provide independently adjustable start and stop comfort conditions.
- Ensure that weather compensation control can be inhibited during preheat periods.
- Ensure that the heating plant goes into full heating mode with full re-circulation of air (if relevant). Ensure a return to normal fresh air control following the optimum start period.

- Provide the optimum start/stop routines with an automatic self-learning process that seeks to reduce any error in achieving the target conditions at the target time.
- Provide the operator with the facility to adjust the following parameters:
    - Target temperature for optimum start
    - Maximum preheat period
    - Target temperature for optimum stop
    - Minimum space temperature for out-of-hours periods
    - Enable/disable the self adaption function
- The default limit time for handover to the weather compensation routines after the start of occupation.
- Ensure that the internal and external air temperature sensors associated with the optimiser are positioned correctly in order to provide representative readings.

310.410 CONTROL FUNCTIONS AND ROUTINES - OPTIMUM START/STOP FOR COOLING SYSTEMS:

- Provide an optimum-start routine for the cooling system to compute the daily minimum pre-cool period necessary to achieve target comfort conditions at occupation start time. Provide an optimum stop routine to compute the earliest time for the cooling system to be shut down in order to retain minimum comfort conditions in the space at the end of occupation.
- Ensure that the optimum start/stop routines have access to the system real-time clock, calendar facility and time programme to define the occupation periods.
- Ensure that routines are capable of operating the ventilation system for building purging prior to optimum start of cooling plant.
- Ensure that it is possible to apply optimum start/stop control both to individual zones and overall plant operation.
- Provide routines to operate chillers and ventilation plant as necessary to achieve the required target conditions while ensuring that heating and cooling systems do not conflict in any controlled zones.
- Provide the operator with the facility to adjust the following cooling system optimum start/stop parameters:
    - Target temperature for optimum start
    - Maximum pre-cool period
    - Earliest time for building purging during out of hours period
    - Inside and outside temperature limits for building purging
    - Separate time/temperature relationships for optimum start and optimum stop
    - Minimum space temperature during building purging
- Ensure that the internal and external air temperature sensors associated with the optimiser are positioned correctly in order to provide representative readings.

310.420 CONTROL FUNCTIONS AND ROUTINES - WEATHER COMPENSATION:

- Provide weather compensation routines to control the heating system in relation to external weather conditions. Provide the operator with the option to adjust temperature and flow-rate settings for the heating system to re-define the weather compensation.
- Provide automatic adjustment to the weather compensation by comparing measured and required space temperatures with the outside conditions, and provide the facility to correct the compensation where a significant difference between the two space temperatures occurs.
- Ensure that abrupt changes in the heating system performance or space temperature shall not adversely affect the automatic adaptive compensation process.

- Provide a single weather compensation curve for each zone irrespective of the number of temperature sensors provided in the zone.
- Ensure that the routines respond to the reset signals arranged to achieve boost, night set-back and boiler safety.
- Ensure that air temperature sensors associated with the compensator are positioned correctly in order to provide representative readings.

310.430 CONTROL FUNCTIONS AND ROUTINES - LIGHTING CONTROL:

- Ensure that the appropriate field controllers can control lighting in the following ways:
    - On/off switching of external and internal lights at fixed times in accordance with the weekly schedules defined by the operator
    - Switching of internal lights based on the signals from external and internal photo sensors. This is to incorporate a user-adjustable delay
    - Switching internal lights off according to occupancy detectors
    - The on/off switching of external lighting based on signals from an external photo sensor
- Ensure that the automatic control of lighting by the BMS is capable of being overridden by local switches and by the operator at the operator workstation.
- Ensure that the lighting control system can be manually controlled in the event of failure of the BMS.
- Provide a facility to monitor, but not control, the emergency lighting.

310.440 SYSTEM COMMUNICATIONS - GENERAL:

- Ensure that the system communications allows the full transfer of monitored, logged, alarm, backup and configuration data between the servers, operator workstation and addressable field controllers.
- Ensure that the communication protocol selected seeks to achieve error-free data transfer. Ensure that the protocol includes an error detection check; includes an error correction and/or re-try technique; limits re-transmission; and raises an alarm condition on failure.
- Ensure that the available bandwidth is sufficient to avoid excessive delays in transmitting data. Ensure that the maximum permissible time delay does not exceed one second

310.460 SYSTEM COMMUNICATIONS - COMMUNICATIONS PROTOCOLS:

- BS EN 61158-2 (fieldbus).
- BS EN ISO 16484-5 (BACnet).
- Modbus. (For third party systems interface to the BMS)
- Modbus over Ethernet. (For third party systems interface to the BMS)
- KNX (BS ISO/IEC 14543-series) (For third party systems interface to the BMS)
-
- Metering data exchange:
    - Smart metering:
        - BS EN 62056-series electricity metering data exchange
        - BS EN 50491-11 HBES smart metering user display
        - PD CEN/TR 16061 smart gas meters
        - PD CEN/CLC/ETSI TR 50572 functional reference architecture for communications in smart metering systems
        - PD CLC/TS 50568-4 and PD CLC/TS 50568-8 electricity metering data exchange
        - BS EN 61968-9 system interfaces for utility metering interface and control

- Field-level protocols
    - Ensure that the selected protocol can:
        - Run on the required communications media copper and optical fiber
        - Provide a communications throughput sufficient for the intended application
        - Provide appropriate network topology options
        - Allow sufficient maximum physical segment length as per the communication standard.
        - Allow sufficient maximum number of nodes for each physical segment and the logical network as per the communication standard.
        - Provide sufficient maximum distance between nodes as per the communication standard.
        - Make use of off-the-shelf network devices such as repeaters, bridges and routers
        - Allow control devices to be powered from the network as per the manufacturer's requirements
- Ensure that the protocol is compatible with fully developed network configuration and management tools.

310.470 SYSTEM COMMUNICATIONS - DIRECT INTEROPERABILITY:

- Ensure that each of the protocol's objects and attributes are consistent with the achievement of the specified level of direct interoperability.
- Ensure that each of the protocol's arrangements for physical connection, data packaging, network management and error detection/correction are the same.

310.480 SYSTEM COMMUNICATIONS - GATEWAYS:

- Ensure that the gateway can
    - Transfer the specified maximum number of points
    - Limit loss of functionality to the level specified
    - Add functionality where specified
- Limit any time delay across the gateway to the maximum
- Ensure that the specified contingency and alarm measures in response to a failure of the gateway are met
- Ensure that the gateway can be modified in response to any future changes relating to the type and amount of data transferred over it.
- Clearly define who has contractual responsibility for the implementation of the gateway.
- Clearly define the demarcation of responsibility for the binding of the points and graphic display.

310.490 SENSORS AND DETECTORS - GENERAL:

- Interface sensors with controllers and indicators via amplifiers or transmitters, where necessary.
- Ensure that all signals are compatible with interfaces fitted to associated field control devices.
- Ensure that the performance of the sensors and detectors are not adversely affected by the following variations in power supply conditions in accordance with BS EN 50160 (with additional voltage drop in the electrical installation defined in BS 7671), or by anticipated conducted and radiated electromagnetic disturbances for the electromagnetic environment in which the sensors and detectors are to be used.
- Ensure that connections to sensors and detectors are of a screw down clamp type or self-locking connectors.

- Ensure that sensors, detectors and meters are installed in accordance with the manufacturer's instructions and recommendations.
- Ensure that calibration conditions for meters are fully documented in the O&M manuals and clearly marked on or adjacent to the meters.
- Ensure that any calibration and maintenance requirements for sensors, detectors and meters are documented in the O&M manuals.

310.500 SENSORS AND DETECTORS - TEMPERATURE SENSORS:

- Standard
  - BS EN 60730-2-9
  - BS EN 14597
- Use RTD or thermocouple assemblies consisting of element, sleeve and connector.
- Connect thermocouple assemblies to the controller
- Sensor
  - Enthalpy.
  - Ductline.
  - Surface.
  - Room.
  - Thimble ceiling tile.
  - Immersion.
  - Outside air.
- Indicator
  - Provide indicator capable of showing measured value at sensor where indicated in the design
- Time constant
  - Space/outside air temperature - 300s still air
  - Duct air temperature - 120s @ 1m/s
  - Water - 30s @ 1m/s
- Ensure that temperature sensors comply with the minimum requirements of the following table.

Table 1 Temperature sensors - minimum requirements

Fluid	Temperature range °C	Sensor accuracy °C
Air	- 10 to + 40	+/- 0.5
Flue gas	+ 30 to + 850	+/- 3.0 (0.75% of FSD above 450°C)
Chilled Water	- 10 to + 30	+/- 0.25
Water	- 10 to + 150	+/- 0.5

310.505 SENSORS AND DETECTORS - INSERTION TYPE TEMPERATURE SENSOR:

- Type [.....]
- Application [.....]
- Use proportional type insertion sensor.
- Sensor

- Average type temperature sensor for mounting over face of air flow in an air-handling unit or in ductwork adjacent to heating coil.
- Thermistor type temperature sensor, minimum stem length 200mm for mounting in the air flow or distribution ductlines.

310.510 SENSORS AND DETECTORS - HUMIDITY SENSORS:

- Standard - BS EN 60730-2-13.
- Measurement
  - Relative humidity.
- Indicator
  - Provide indicator capable of showing measured value at sensor where indicated in the design.
- Time constant - 300@ 1m/s.
- Ensure that humidity sensors comply with the minimum requirements of the following table.

Table 2 Humidity sensors - minimum requirements

Sensor	Humidity range	Sensor accuracy
Humidity	10 to 90%	+/- 5% RH

310.520 SENSORS AND DETECTORS - AIR VELOCITY SENSORS:

- Method
  - Pitot static tube array.
- Ensure that air velocity sensors comply with the minimum requirement of the following table.

Table 3 Air velocity sensors - minimum requirements

Sensor	Sensor range	Sensor accuracy
Pitot static tube	3 to 80 m/s	+/- 2% of reading
Thermo-electric anemometer	0 to 20 m/s	+/- 3% of reading or +/- 0.1 m/s whichever is greatest

310.530 SENSORS AND DETECTORS - AIR PRESSURE SENSORS:

- Use pressure transducers manufactured in stainless steel.
- Voltage output 0-10V DC
- Connect pressure transducers, via matched transmitters to
  - Single way display/alarm/control unit.
  - Provide indicator capable of showing measured value at sensor where indicated in the design.
- Ensure that air pressure sensors comply with the minimum requirements of the following table.

Table 4 Air pressure sensors - minimum requirements

Sensor	Sensor range	Sensor accuracy
Air pressure	-	+/- 2% of reading

310.535 SENSOR AND DETECTORS - FLOW SENSORS:

- Type [.....]
- Application [.....]
- Standard - BS EN 60730-2-15.
- Provide flow detectors and connect to display/alarm/control unit
- Sensor
    - Venturi.
    - Differential pressure transducer.
    - Electro-magnetic meter.
    - Computed mass flow.
    - Turbine flow.
    - Oscillating vane.
    - Paddle wheel.
    - Nozzle.
    - Magnetic flow.
    - Vortex.
- Sensor range [.....]
- Sensor accuracy [.....]
- Time constant 5 seconds.
- Indicator.

310.540 SENSORS AND DETECTORS - FLOW METERS:

- Type [.....]
- Application [.....]
- Ensure that meters comply with the minimum requirements of the following table.

Table 5 Flow meters - minimum requirements

Meter	Meter range	Meter accuracy
Fuel flow meter	0 to 10 Hz	3% of reading
Water flow meter	>> 5:1	2% of reading
Electricity meter	-	1.5% of reading

310.545 SENSORS AND DETECTORS - LEVEL SENSORS:

- Type [.....]
- Application [.....]
- Provide liquid level detectors and connect, via matched amplifiers, to
    - Single way display/alarm/control units.
    - Multi-way display/alarm/control units.
- Sensor
    - Use capacitance electrodes manufactured from stainless steel and PTFE insulation for use on conductive liquids with a minimum conductivity of 0.01 S/m.
    - Use conductivity electrodes manufactured from stainless steel, either single or multi-tipped.
    - Float type to BS EN 60730-2-15.
- Indicator

- Provide indicator capable of showing measured value at sensor. Calibrate indicators

310.546 SENSORS AND DETECTORS - OTHER SENSORS:

- Type
  - Smoke.
  - Specific gravity.
  - Quantity.
  - CO_2.
  - CO
    - BS EN 50291-1
    - BS EN 50292
  - Refrigeration gases.
  - Combustible gases and oxygen.
    - BS EN 50271.
    - Equipment for use in explosive atmospheres to be in accordance with BS EN 60079-29-1 and installed in accordance with BS EN 60079-29-2
  - Turbidity.
  - Flame ignition failure.
- Sensor range [.....]
- Sensor accuracy [.....]
- Time constant [.....]
- Indicator
  - Provide indicator capable of showing measured value at sensor. Calibrate indicator

310.555 TRANSMITTERS:

- Type [.....]
- Application [.....]
- Use transmitters to interface between sensor and controller, utilizing only one sensor.
- Use transmitters
- Input
  - Input span [.....]
  - Zero offset [.....]
  - DC
  - AC
  - True rms [.....]
  - Voltage [.....]
  - Current [.....]
  - Frequency [.....]
  - Pulse rate [.....]
  - On/off.
  - Resistance [.....]
    - Resistance thermal device (RTD) to BS 1041-3
    - Resistance thermal device (RTD) to BS EN 60751.
  - Thermocouple to BS EN 60584
  - Strain gauge [.....]

- Lead resistance [.....]
- Bandwidth [.....]
- Bias current [.....]
- Input resistance [.....]

310.565 TRANSDUCERS:

- Type [.....]
- Application [.....]
- Manufacturer and reference [.....]
    - Or approved equivalent.
- Use transducers to receive 0-20V dc signal from controller and to convert it to proportional 0-15 psi output. When using transducers use electromagnetic actuators.
- Transducer
    - Electro-pneumatic.
    - Electro-hydraulic.

310.600 SWITCHES AND THERMOSTATS

310.605 AIR DIFFERENTIAL PRESSURE SWITCHES:

- Type [.....]
- Application [.....]
- Adjustment range for trip pressure [.....]
- Maximum operating pressure [.....]
- Electrical rating [.....]
- Ambient temperature limits [.....]
- Reset differential [.....]
- Maximum differential pressure overload [.....]

310.610 AIR THERMOSTATS - ROOM TYPE:

- Type [.....]
- Application [.....]
- Standard
    - BS EN 60730-2-9.
- Position
    - Wall-mounted.
- Ancillaries
    - Built in set point potentiometers.
    - Heat anticipators.
    - Night set-back.
    - Range inserts, when using thermostats in series.
    - Fixed set points.
    - Tamper-proof cover.
    - Remote set point adjustment.
    - Time switch.
    - Controller.

- Reverse action.
- Combined humidistat.

310.620 AIR THERMOSTATS - SURFACE TYPE:

- Type [.....]
- Application [.....]
- Standard
  - BS EN 60730-2-9
  - BS EN 14597
- Use surface type thermostats on
  - Pipelines
  - Windows

310.625 AIR THERMOSTATS - MULTI-STEP TYPE:

- Type [.....]
- Application [.....]
- Steps [.....]

310.630 AIR THERMOSTATS - MASTER TYPE:

- Type [.....]
- Application [.....]
- Provide master type thermostats to measure conditions at one point and reset the point of another (sub-master) thermostat or controller.

310.635 AIR THERMOSTATS - REMOTE BULB TYPE:

- Type [.....]
- Application [.....]
- Connect via
  - Cable
  - Capillary
- Ancillaries
  - Clamp-on detector for pipelines.
  - Solar collector detector.
  - Immersion detector and pocket.
  - Insertion detector.

310.640 AIR THERMOSTATS - FROST PROTECTION TYPE:

- Type [.....]
- Application [.....]
- Standard
  - BS EN 60730-2-9
  - BS EN 14597
- For space mounting use frost protection thermostats with temperature range of 0-20°C and with SPST switching action and electrical rating of 20 amps resistive.

- For heater battery protection use frost protection thermostats consisting of a gas filled sensing element and a bulb, a directly adjustable set point and switching differential.
- For compensated systems use external frost type thermostats with proportional type sensor, the whole unit being weather-proofed.
- Ancillaries
    - Clamp-on temperature detector.
    - Immersion type temperature detector.
    - Controller.
    - Start-up switching and indication.
    - Manual or automatic reset facility.

310.645 WATER IMMERSION THERMOSTATS:

- Type [.....]
- Application [.....]
- Standard
    - BS EN 60730-2-9
    - BS EN 14597
- Use proportional type immersion thermostats with rigid sensing elements ensuring 50mm minimum length is immersed. Use separable pockets, screwed 15mm BSP.
- Pocket material
    - Copper.
    - Corrosion resistant bronze.
    - Stainless steel.

310.650 HUMIDISTATS:

- Type [.....]
- Application [.....]
- Use wall-mounted resistance element type humidistats.
- Room humidity.
- Enthalpy.

310.700 ACTUATORS:

- Include position feedback devices suitable for connection to the BMS.
- Ensure that actuators incorporate a disconnection device to allow manual operation of the valve or damper in the event of actuator failure.
- Where line voltage actuators are used, provide local means of isolation by manual isolator or plug and socket connection.

310.705 ACTUATORS - SOLENOID TYPE:

- Type [.....]
- Application [.....]
- Standard
    - BS EN 60730-2-8.
- Control mode
    - Linear.

        - Proportional.
    - Operation
        - Normally open.
        - Normally closed.
        - Modulating.
    - Ancillaries
        - Spring return.
        - Power failure return.
        - Positioners.
        - Manual control failures.

310.710 ACTUATORS - ELECTRONIC TYPE:

- Type [.....]
- Application [.....]
- Standard
    - BS EN 60730-2-8
- Use low voltage, high torque, electronic type actuators, including mounting brackets, adjustable linkages and necessary attachment devices.
- Control mode
    - Linear.
    - Proportional.
    - Compensating.

310.715 ACTUATORS - ELECTRIC MOTOR:

- Type [.....]
- Application [.....]
- Operation
    - Unidirectional.
    - Reversible.
    - Synchronous.
    - Asynchronous.
        - Provide thermal overload protection with manual reset option.
    - Spring return.
- Control mode
    - Linear.
    - Proportional.
    - Compensating.
- Operation
    - Two-position (ON-OFF).
    - Continuous.
    - Modulating.
- Electrical requirements

- Integral terminal strip or DIN plug and socket connections.
- Two end of travel limit switches, with adjustable cam operation for motor de-energisation.

- Mechanical requirements
  - Self locking gear train.
  - Manual override, geared to prevent backdrop.
  - Travel stops in each direction.
  - Position indicator.
  - Enclose to IP65 minimum.
- Ancillaries
  - Auxiliary switches.
  - Heater.
  - Potentiometers.
  - Proportional current feedback modules.
  - Positioners.
  - Speed adjustment modules.
  - Integral controllers.
  - Manual control facilities.
  - Power failure return.
  - Spring return.

310.800 VALVES AND DAMPERS:

310.805 MOTORISED VALVES:

- Type [.....]
- Application [.....]
- Standard
  - BS EN 60730-2-8
  - Relevant parts of BS EN 60534
- Duties and details as schedule reference Motorised Control Valves
- Type
  - Single seat, on/off
  - Double seat, on/off
  - 3-way mixing, modulating
  - 3-way diverting, modulating
  - Pressure Independent Control Valve (PICV) - tested in accordance with BSRIA BTS 1/2012
  - Butterfly, on/off
- Material
  - Brass to BS EN 12163, BS EN 12164 or BS EN 12167.
  - Copper alloy to BS EN 1982.
  - Cast iron to BS EN 1561.
  - Cast steel to BS EN 10213.
- Connections
  - Screwed to relevant parts of BS EN 10226
  - Flanged to BS EN 1092-3

    - Cast steel only, flanged to BS EN 1092-1
    - Cast iron only, flanged to BS EN 1092-2
    - Aluminium alloy only to BS EN 1092-4
    - EPDM
    - PTFE
- Ancillaries
    - Position indicator
    - Locking device
    - Control device and linkage mechanisms
    - Lever for manual operation
- Actuating motive power
    - Electric motor.

310.900 DAMPERS:

310.905 MOTORISED DAMPERS:

- Type [.....]
- Application [.....]
- Use motorised control dampers manufactured and installed in accordance with Building Engineering Services Association specification DW/144.
- Actuating motive power
    - Electric motor.

310.910 MOTORISED SHUTTERS:

- Type [.....]
- Application [.....]
- Use motorised shutters manufactured and installed in accordance with Building Engineering Services Association specification DW/144.
- Actuating motive power
    - Electric motor.

320.000 INSTALLATION:

320.050 FIXING AND CONNECTION - CABLING INSTALLED AS PART OF THE BMS CONTRACT:

- Plan and install all building management monitoring systems cables in accordance with the cable manufacturer's recommendations.
- Label and record all monitoring cables in accordance with
    - Approved Cable schedules
    - Approved shop drawings
- General
    - This part of the specification covers extra-low voltage wiring (as defined by BS 7671), i.e. signal and data communications wiring.
    - Install all cabling in accordance with BS EN 50173-1-series, BS EN 50174-series and BS EN 7671 (IET Wiring Regulations).

- All cabling must be adequately protected from the environment through which it passes to avoid the possibility of mechanical damage and electromagnetic interference.
- Install cabling and conduits associated with sensors in a manner that prevents spurious transfer of moisture and heat etc from external sources to sensing devices.
- Ensure that all wiring is carried out in a neat manner by skilled operatives. Clip wiring to form a loom and route it to avoid interference with the correct operation or maintenance of other components.

- Cable type and application
  - Ensure that the types of cable installed do not prejudice satisfactory operation of the BMS.
  - Ensure that the type of cables, installation and planning comply with the BMS manufacturers recommendations and the project's electrical specification.
  - Ensure that the cross-sectional area of cables is sufficient to ensure that sensor circuit resistance limits are not exceeded.
  - Ensure that the method of installation and routing of cables does not compromise the satisfactory operation of the BMS.
  - Ensure that the minimum separation distances between data/analogue signal cables and cables of other services (including power cables) comply as relevant with BS 7671 and BS EN 50174-series.

- Identification
  - Ensure that all cables have identification sleeves at their terminations which combine the requirements of BS 7671 with those for specific circuit identification. Ensure that the identification is consistent with the relevant wiring diagrams.

320.060 FIXING AND CONNECTION - USE OF EXISTING CABLE AND WIREWAYS:

- Confirm by testing or obtain appropriate certificates from original suppliers that any existing means of network communication is of a suitable standard for satisfactory operation of the BMS.
- Ensure that any tests performed comply with relevant parts of BS EN 50174.
- Ensure that the potential corruption of data cannot arise from:
  - Other installations not connected to, but in close proximity to, the route of existing cabling
  - Other electrical services using existing cabling
  - Other adjacent cabling
- State in writing at the time of tender whether or not existing cabling is suitable.

320.070 FIXING AND CONNECTION - CONNECTION TO PLANT AND CONTROL EQUIPMENT:

- General
  - Provide all devices and terminals necessary to connect the BMS to items of plant and control equipment.
  - Take account of any existing services that have to remain in continuous operation. Provide for approval, an installation and commissioning plan that identifies how the BMS equipment can be installed an commissioned without disrupting the operation of the existing building services.
  - Where plant and control equipment are supplied by others, provide the adequate interface and integration (physical and functional) needs for installation and commissioning requirements. Provide this information in time and in sufficient detail to enable any other installers and their suppliers to incorporate the BMS connection facilities before delivering their equipment to site.

- Where plant is subject to warranty by others, obtain clearances in writing from those concerned that the proposed modifications do not invalidate the warranties.
- Ensure that modifications carried out as a result of the contract are fully documented and do not affect the satisfactory operation of safety devices connected to any plant or systems affected directly or indirectly by the BMS works. Carry out proving tests to the satisfaction of the Project Supervisor.
- Ensure that the use of existing relays, contactors, starters and switches as part of the BMS installation is fully documented.

- Safety interlocks
  - Provide interlocks as scheduled to establish and maintain safe/pre-determined plant conditions under all modes of operation including fire mode loss, reduction and restoration of power.
  - Ensure that all safety hard-wired interlocks are wired in a closed-loop application to failsafe on loss of power, or on relay coil failure, or on open circuit, e.g. cable breakage.
  - Ensure that all interlocks use voltage-free contacts and AC or DC 24 V relays and field wiring.
  - Complete all wiring and testing of all hard-wired safety interlocks to ensure safe and/or sequenced operation of the plant before the BMS is set to work. Arrange interlocks to prevent unsafe or out of sequence operation of the plant by the BMS.
  - Ensure that plant does not operate using the BMS until all interlocks have been tested to the satisfaction of the Project Supervisor.

- Manual control
  - Provide manual control facilities to enable plant maintenance/facilities staff to operate essential plant in the event of BMS failure and for routine test purposes. Ensure that the facilities include:
    - Start/stop operation of the plant.
    - Automatic operation of motorised control devices such as valves and dampers, etc if the BMS is operating.
    - Manual setting of motorised control devices such as valves and dampers, etc if the BMS has failed.
  - Ensure that the manual control facilities do not override safety devices or hard-wired interlocks.

- Volt-free contacts
  - Ensure that the contact materials are suitable for use in the installation and at the required voltages and currents.
  - Use screw down or locking spade terminals for electrical connections to volt-free contacts.

- Relays
  - Use demountable relays of the totally enclosed type.
  - Use relays with circuit arrangement printed on top.
  - Use screw down clamp or locking spade-terminals, and ensure they are shrouded.
  - Use relays with LED or flag indication of coil status.

- Signalling from starters
  - Provide additional contacts for signalling and remote operation purposes

- Control equipment

- Obtain advice from the relevant supplier when additional facilities are to be fitted to control equipment supplied by others.
- Use the knockouts, cable routes and terminals, etc incorporated into the design of control devices.

- Packaged plant
  - Ensure that connections to packaged plant are made within the packaged plant control panel. Fit an additional enclosure where this is not possible. Ensure that all connections between the BMS and packaged plant are 24 V maximum.

320.080 FIXING AND CONNECTION - ADDITIONAL PROVISIONS FOR RETROFIT INSTALLATIONS:

- Arrange for any necessary control modifications to existing plant to be carried out by the original supplier (with the exception of starter panels). Give the supplier details of the requirements for connection of equipment to the BMS. State the name of the supplier in the Tender together with a priced schedule for the necessary work.
- Where details of existing plant are not available from the original supplier or from record documents, provide a specialist conversant with the particular type of plant to carry out any necessary modifications. Provide the specialist with the details of the BMS connections required. State the name of the specialist in the Tender together with a priced schedule for this work. Advise the Project Supervisor of any difficulties with connections.
- Advise in writing at the time of tender of any potential delay to the contract arising from the difficulty of providing the necessary BMS connections to the plant.
- Use existing relays and volt-free contacts where feasible.
- Fit auxiliary contacts to contactors, etc where adequate space is available. Install additional relays if the space is not adequate.
- Obtain advice from the original supplier when additional facilities are to be fitted to existing control equipment.
- Use the control manufacturer's standard accessories to provide any additional contacts, limit switches and potentiometers, etc.
- Use the knockouts, cable routes and terminals, etc incorporated into the design of control devices wherever possible. Obtain approval from the Project Supervisor for ad hoc fixings and modifications to control devices before action is taken on-site.

320.090 FIXING AND CONNECTION - CABINETS FOR BMS EQUIPMENT:

- Construct BMS equipment enclosures to give the minimum degree of protection to IP54 in accordance with BS EN 60529. Enclosers installed outdoors should be to IP65.
- Ensure that access doors are of a rigid construction and mounted on stout metal hinges capable of supporting the full weight of the open door. Ensure that doors will not sag or drop when open. Fit doors with stout locking handles to prevent access by unauthorised personnel.
- Allow safe access to the BMS equipment where the BMS equipment is incorporated into another control panel without having to isolate the panel.

320.100 CONTROL PANELS - DESIGN, CONSTRUCTION AND INSTALLATION:

- Standards
  - BS EN 63044-series for controllers
  - Relevant parts of BS EN 61439-series where the control panel forms part of switchgear and/or controlgear as defined in the standard
  - BS EN 60204-1 where the control panel may be considered to form part of machinery as defined in the Supply of Machinery (Safety) Regulation 2008

- BS 7671 (IET Wiring Regulations)
- BS EN 62208 for enclosures

- Control panel design
  - Ensure that the layout of control panels reflects the layout of the plant being served. Ensure that indicators and controls for associated plant are grouped.
  - Ensure that all doors on panels containing exposed dangerous voltages are provided with interlocked isolators such that the door cannot be opened except with the isolator in the 'off' position. Ensure that isolation complies with BS 7671.
  - Ensure that equipment that requires on-line adjustment and testing by non-electrically qualified personnel is accessible and usable without interrupting the supply or overriding safety interlocks. Ensure that in general, field controllers are not located within control panels where isolation is necessary to gain access.
  - Design panels to maintain all components within their environmental tolerance limits taking into account ambient environmental conditions. Install fans with thermostatic control and air extract grilles and air intake grilles with replaceable filters where mechanical ventilation is required to control the environmental conditions. Ensure that the specified ingress protection (IP) ratings are maintained.

- Input power supply
  - Voltage and frequency
    - AC **[230]** V 50 Hz single-phase.
    - AC **[400]** V 50 Hz three-phase.
    - DC 24 V protective extra-low voltage (PELV).
    - DC 48 V protective extra-low voltage (PELV).
    - [.....]
  - Supply variations to input voltage and supply frequency to relevant parts of:
    - BS EN 61439
    - BS EN 60038 including voltage drop in accordance with BS 7671 (IET Wiring Regulations)
    - [.....]
  - [.....]

- Usage
  - Control panel.
  - Motor Control Centre (MCC).
  - Single starter enclosure.
  - [.....]

- Electrical ratings
  - Rated operational voltage [.....]
  - Rated insulation voltage [.....]
  - Rated current [.....]
  - Rated short-time withstand current [.....]
  - Rated peak withstand current [.....]
  - Rated prospective short-circuit withstand current [.....]
  - Rated conditional short-circuit current [.....]
  - Rated fused short-circuit current [.....]
  - Rated diversity factor [.....]
  - Prospective short-circuit current [.....]

- Arising from rotating machine [.....]
- Co-ordinate short-circuit protection devices [.....]
- [.....]

- Service conditions
  - Ambient air temperature to relevant parts of BS EN 61439.
  - Suitable for ambient air temperature for outdoor installations [.....]
  - Altitude to relevant parts of BS EN 61439.
  - Suitable for use at altitudes above 1000m.
  - Electromagnetic compatibility
    - Environment A to BS EN 61439-1 (industrial)
    - Environment B to BS EN 61439-1 (domestic and light industrial)
    - Remedies for electrical and radiated interferences [.....]
  - Special service conditions [.....]
  - Conditions during transport, storage and erection [.....]
  - Provide facilities to allow future extension of switchboard.

- Control panel construction
- Enclosure material
  - Steel
    - Painted mild steel
      - Finish [.....]
      - Colour [.....]
    - Stainless steel grade [.....]
    - Plastic [.....]
    - Minimum thickness (mm) [.....]
  - Demountable back panel
    - Galvanised steel [.....]
    - Insulating laminated plastic [.....]
    - [.....]
  - BS EN 60529 ingress protection (IP) rating:
    - IP41 for units installed in other plant or equipment enclosures offering higher IP ratings
    - IP54 for units installed inside buildings
    - IP55 for units installed in boiler rooms and pump rooms
    - IP65 for units installed outdoors
    - Degree of mechanical protection to BS EN 62262, IK [.....]
    - Ensure that all terminations accessible when the control panel is open are fully shrouded, recessed or otherwise protected against accidental contact to at least IP2X or IPXXD.
  - Enclosure door / access panel fastenings:
    - Screw or bolt
    - Locks
      - Type
        - Thumb-lock with integral key

- Multipoint locking system
  - T-handle
  - Flush-folding handle
  - [.....]
- Key type [.....]

- [.....]

- [.....]
- Ensure that control panels weighing more than 50 kg including installed components are fitted with eyebolts to facilitate delivery and installation.
- Ensure that panels are provided with adequate undrilled and/or detachable gland plates of sufficient size and strength to accept glands for all types of cable conduits and cable trunking intended for termination within the panel.

- Internal wiring
  - Standard
    - BS 6231 polyvinyl chloride (PVC) insulated tri-rated switchgear cable [.....]
    - BS EN 50525-3-41 low smoke zero halogen (LSZH) cable [.....]
    - BS 6701, BS EN 50173-series and BS EN 50174-series for telecommunications cables
    - [.....]
  - Identification of conductors
    - Comply with the following standards, as relevant:
      - BS EN 60445 core standard for identification of conductors
      - BS 7671 for wiring forming part of the electrical installation
      - BS EN 60204-1 for control panels that are classed as a component of machinery in accordance with Supply of Machinery (Safety) Regulations 2008
      - BS EN 61439-series for switchgear and controlgear assemblies
      - BS 6701, BS EN 50173-series and BS EN 50174-series for telecommunications cables
    - Identification of earthing and bonding conductors
      - Ensure protective conductors are identified in accordance with BS 7671 and BS EN 60445.
      - Ensure dedicated telecommunication functional earth conductors are identified and labelled in accordance with BS 6701.
      - Ensure combined protective earthing and functional earthing conductors are identified primarily as protective conductors.
    - Control wiring
      - Segregate control and auxiliary contact wiring from power circuits and data communications circuits
      - Provide electrical separation for voltages of different bands in accordance with BS 7671, BS EN 60204-1 and BS EN 61439.
      - Contain control wiring in slotted plastic trunking
  - Take account of thermal effects, temperature internal to the control panel, and grouping, for all wiring.

- Wire termination practice
    - Identify every wire at each end with a unique wire number according to the control panel drawings and cable schedule. Wire numbers may be formed from numbers and uppercase letters. Ensure the system used cannot be confused with alphanumeric conductor function identification requirements of BS EN 60445 and BS 7671.
    - Terminate wiring intended for screw terminals with ferrules to prevent damage to conductors, and facilitate fault finding and maintenance replacement of components.
  - Arrange all wiring within the panel in looms and/or perforated trunking. Ensure that all cables are run continuously from terminal to terminal without intervening joints.
  - Ensure sufficient spare capacity in cable ways and trunking to comply with BS 7671 (IET Wiring Regulations).
  - Ensure that flexible looms are used to connect door mounted to interior-mounted components such that wires will not weaken or break with repeated door openings. Arrange the loom to avoid pinching or looping when the door is closed and ensure that it is fully supported at each end.
- Provide DIN-rail mounting for equipment and terminate to
  - BS EN 60715 dimensional type designation:
    - Top-hat TH 15-5,5
    - Top-hat TH 35-7,5
    - Top-hat TH 35-15
    - Top-hat TH 75-25
    - C-section C 20
    - C-section C 30
    - C-section C 40
    - C-section C 50
    - G-section G 32
  - Ensure steel DIN-rails are manufactured and finished in accordance with Appendix A to BS EN 60715.
- Location
  - Do not locate outstations within control panel compartments where isolation is necessary to gain access.
- Control panel labelling
  - Ensure that all panels and individual panel sections are provided with exterior labels to BS EN ISO 7010 and BS 7671 (IET Wiring Regulations) indicating the voltage within the panel along with clear warnings of risk and instructions for isolation. Display requirements for informing the BMS supervisor and/or disabling alarms prior to isolation of control circuits.
  - Label all switches, controls and indicators on control panels as to function and associated plant.
  - Fix a notice to the front of the panel warning of the need for isolation elsewhere if the panel does not totally control the electricity supply to associated plant.
  - Identify all cables with permanently fixed alphanumeric labelling system. Ensure that the numbering corresponds to the numbers fixed to the terminals. Ensure that identification and coding matches that used on the design drawings, schematics and schedules.

- Lights
    - Use LEDs
    - Use lens colours in accordance with BS EN 60073.
- Audible alarms
    - Ensure that operation of any starter trip lamp, safety circuit lamp or alarm lamp operates a common audible alarm with mute and test facilities and terminals for remote alarm signal.
    - When an alarm condition has had the audible alarm muted, ensure that terminals for a remote 'alarm accepted' light are energized. The audible alarm circuit and terminals for remote alarm signal must still be capable of indicating another fault occurring even though original fault has not been cleared. The test facilities are to test momentarily both the audible alarm and alarm indicator lamps, whilst the push button is depressed.
    - Use alarms that interface with a sensor or controller to sense set-point and measured value. Provide adjustable upper and lower limits on face of unit. Provide unit with indicating lamps to show which limit has been exceeded. Provide each unit with connections for remote alarm.
- Surge and transient suppression
    - Ensure surge arrestors are fitted for star-connected and star-delta started motors to limit peak voltage to 1200 V.
    - Ensure transient suppressors in the form of resistor and capacitor networks are fitted across starter contactor coils.
- Controlgear
    - Terminals for external conductors
        - For main power circuits, accommodate cross-sectional area of copper cables in accordance with BS EN 61439-1, Appendix A.
        - Size neutrals on 3-phase supplies to take account of harmonic content (triple-n's) where relevant, with a minimum of the full current-capacity of the corresponding phase conductors.
        - For control and auxiliary circuits, provide terminal blocks suitable for DIN rail mounting on top-hat rails dimensional type TH 37-7,5 to BS EN 60715.
    - Accessibility for inspection
        - Arrange for following operations to be performed when assembly is in service and under voltage.
        - Visual inspection of switching devices and other apparatus, settings and indicators of relays and releases, conductor connections and markings.
        - Adjusting and re-setting of relays, releases and electronic devices.
        - Replacement of fuse links and indicating lamps.
        - Fault location by voltage and current measuring.
    - Accessibility for maintenance
        - Provide space between functional unit or group and adjacent functional units or groups. Provide retainable fastening means for parts likely to be removed for maintenance.
        - Use barrier protected sub-sections for each functional unit or group.
        - Use compartments for each functional unit or group.
    - Removable parts and withdrawable parts

        - Degree of protection of assembly after removal or withdrawable of part as manufacturer's standard.
        - [.....]
    - Internal separation
        - Form 1
        - Form 2a
        - Form 2b
            - Type 1
            - Type 2
        - Form 3a
        - Form 3b
            - Type 1
            - Type 2
        - Form 4a
            - Type 1
            - Type 2
            - Type 3
        - Form 4b
            - Type 4
            - Type 5
            - Type 6
            - Type 7
    - [.....]
- Mounting
    - Floor standing
    - Wall-mounted
- Access for cabling
    - Front [.....]
    - Top [.....]
    - Bottom [.....]
    - Rear [.....]
    - Side [.....]
- Site modification
    - Do not make site alterations unless authorised. Where site modifications to assemblies are authorised make in accordance with manufacturer's certified drawings and instructions. Ensure that modifications made comply with type test certificate obtained for arrangement of components.
- Provide document pocket inside the control panel, complete with full control panel schematic and wiring schedule.
- [.....]

320.110 SENSORS - GENERAL:

- Ensure that sensors can be removed for testing and maintenance.
- Ensure that a tight-sealing test hole is provided adjacent to every duct sensor. Ensure that Binder test points, or similar, are provided for pipe sensors.
- Provide a sufficient length of spare cable so that the sensor can be removed without disconnecting the wiring.
- Mark and record the location of concealed sensors (e.g. in false ceilings and shafts, etc).
- Provide a labelling plate for each sensor.
- Take account of the active and inactive sections of a sensor probe.
- Take into account the effects of orientation on the functioning of the sensor.
- Take into account:
    - Minimum/maximum ambient temperature
    - Ambient humidity
    - Vulnerability to spray water and/or vibration
    - Explosion protection
    - External influences

320.120 TEMPERATURE SENSORS:

- Pipe-mounted immersion sensors
    - Ensure that the full active length of the sensor is immersed in water.
    - Install sensors against the direction of flow.
    - Install at the correct angle.
    - The sensor should be installed diagonally in a bypass pipe or in a bend if the active length of the sensor probe is longer than the diameter of the pipe.
    - Allow an adequate space between the sensor and the obstruction so that the sensor can be removed from the immersion pocket.
    - Ensure that immersion pockets are made from stainless steel of the appropriate pressure rating.
    - Ensure that immersion pockets are filled with a heat conducting compound.
    - A test point or an additional immersion pocket, adjacent to the sensor, should be provided for test purposes.
    - An adequate distance (10 x pipe OD) between the mixing point and the sensor should be provided when mixing water at different temperatures to take account of stratification.
- Surface temperature sensor - water
    - Ensure a smooth clean contact surface and fill the space between the sensor and the pipe with a heat conductive compound to improve thermal conductivity.
- Immersion sensors for air (ducts)
    - The full active portion of the sensor probe should be exposed to the air flow.
    - Ensure that the active portion of the probe is located central to the airflow with telescopic extendable probe type sensors.
    - A test hole should be provided adjacent to every sensor with plug when not in use.
    - Probe-type sensors should not be used in areas where stratification can occur, e.g. downstream of heating and cooling coils, etc (see averaging sensors).
    - Sensors which are positioned near to coils should be shielded against the radiative heat transfer.
    - Return air duct sensors should be located near to the occupied space to avoid heat gain or loss and radiant effects influencing readings.
    - Sensors must be positioned in an area of representative air flow. This applies to all duct sensors but particularly the return air sensor which may be located in the ceiling plenum.

- The likely cleanliness of the air should be considered when selecting sensors.
- Sensors representing zone temperature should be offset to account for heat gains e.g. space temperature stratification or if light fixtures are used as the return air path.
- Sensors should only be used in return air ducts where air is continuously extracted.

- Capillary sensors with probes
  - The device head must be higher than the sensor probe.
  - The sensor probe should be tilted downwards.
  - The ambient temperature at the device head must always be higher than the temperature to which the sensor probe is exposed.
  - The sensor element must always point downwards. The capillary should not form a U-shape.
  - The capillary should not be bent too tightly (radius of bend >50mm).

- Averaging sensor (for use in ducts/AHU)
  - Allow a distance of at least 50 mm between any heat exchanger and the sensor.
  - The entire length of an averaging sensor must be fully inside the air-duct.
  - The sensor element must be evenly distributed over the full cross-section and adequately secured to prevent vibration.
  - The sensor element should be installed in the air flow, downstream of the eliminator plate when air washers are used for humidification.

- Frost protection thermostat
  - Leave a spare capillary loop of 20 cm to enable sensor testing outside the duct/unit.
  - The capillary loop must be insulated to protect against low plant room temperatures.
  - The measuring head and the test loop of the thermostat must be located inside the ductwork and downstream of the heat exchanger if the ductwork is outdoors or in an unheated space.
  - The capillary should be installed in the air flow, downstream of the first heating coil exposed to frost. The capillary must be installed diagonal to the heat exchanger pipes or in a serpentine manner at right angles to the pipes.

- Room sensor
  - Sensors should be installed at a height of 1.5 m in occupied spaces and at least 50 cm from any adjacent walls.
  - Where room sensors have an adjustable dial they shall be mounted at 1.2m.
  - The sensor should be located in an area representative of the entire control zone.
  - The sensor should be located away from heat sources, e.g. office IT equipment.
  - The sensor should be located in the area it controls.
  - Sensor locations near air currents generated by diffusers or openable windows, for example, should be avoided.
  - The sensor must not be exposed to direct solar radiation.
  - Avoid external walls except were unavoidable. Use insulated backplates.
  - Avoid recesses and alcoves.
  - The conduit entry points to the sensor wall box should be sealed where there is a risk of air from another zone flowing over the sensor element.
  - Do not install near or under lamps or above radiators.
  - Avoid chimney walls.
  - Do not install directly adjacent to doors.
  - Do not install behind curtains.
  - Do not fit to walls concealing hot-water pipes.

- Outdoor air temperature sensors

- Do not install on facades affected by significant rising heat, or facades which will be heated by solar radiation (fix sensors to a north-facing wall or use solar shields).
- Avoid chimney walls and other walls subject to high internal heat gains.
- Do not install under eaves.
- Do not install above windows.
- Do not install above ventilation extracts.
- Ensure accessibility for inspection/verification.
- An alternative to an external mounting is to locate the sensor in the AHU intake duct. This should ideally be upstream of the intake damper and on AHU plant which run continuously (24/7). Where this is not possible it must be a suitable distance before re-circulated air and mechanical devices to avoid their effects.

320.130 HUMIDITY SENSORS:

- Humidity sensor/stat. - duct
  - The air velocity in the vicinity of the sensor must not exceed 10 m/s (a perforated steel plate cover can be used).
  - The sensor must not be located in dead legs (super-saturation can occur in areas where there is no air flow).
  - A test hole must be provided downstream of the sensor, plugged off when not in use.
  - The sensor should be positioned beyond the spray distance of humidifiers.
- Humidity sensor/stat. - room
  - The sensor should be installed at a height of approximately 1.5 m in the occupied space and at least 50 cm from the adjacent wall
  - Avoid locations where the sensor will be exposed to direct solar radiation
  - Avoid external walls except were unavoidable. Use insulated backplates
  - Avoid alcoves and recesses
  - Do not install near lamps or above radiators
  - Do not fit to chimney walls
  - Do not fit directly adjacent to doors

320.140 PRESSURE SENSORS:

- Pressure - general
  - Pressure sensors are affected by orientation.
  - The pressure tubes must be provided with a binder point near the device head for test purposes.
  - The connection must be fitted with a bypass with a stop valve to avoid overload on one side when manipulating the sensors and to enable zero calibration. Isolating valves should also be fitted.
  - The sensor should be installed on a vibration-free surface or vibration-proof base.
  - The pressure-tapping point must not be located in turbulent air flow. Provide 6 x OD upstream and 6 x OD downstream of straight duct or pipe without obstructions.
- Pressure - air
  - Probes for measuring static pressure should be installed parallel to the flow.
  - The differential pressure measuring tube should be correctly sized.
  - The tapping point should not be located where it will be affected by obstructions to the flow.
- Pressure - liquids

- Use a damping coil to avoid transferring vibrations (horizontal loops to avoid trapped air bubbles and condensate).
- The device must always be installed in a location which is lower than the sensing point.
- Do not measure at the top of a pipe (trapped air, bubbles) or at the bottom (dirt).

- Pressure - gases
  - When measuring vapour gases the device must always be installed in a location which is higher than the sensing point.
  - Measure at the top of the pipe to prevent condensate from entering the pressure tube.

320.150 FLOW VELOCITY/FLOW RATE SENSORS:

- Differential pressure for flow monitoring - liquids
  - There should be no stop valves or balancing valves between the sensing points on the pipework.
- Differential pressure for flow monitoring - air
  - Ensure a steadying zone upstream and downstream of the orifice plate/flow grid, etc.
  - The flow or differential pressure must not be monitored where there is a variable resistance such as a filter or fan, etc.
- Velocity sensors
  - Sensors should be positioned at an adequate distance from bends, tees, fans and coils such that the centre line velocity is representative of the average velocity.
  - A single point sensor should be located at a distance from the centre of the duct equal to 0.25 x the duct radius.
- Wilson flow grid
  - Averaging velocity sensors across the duct, e.g. Wilson flow grid or multi-point averaging pitot tubes, should be used where the minimum separation distance from a flow disruption is not available. Ensure that the Wilson flow grid is sized correctly for each duct size.

320.160 INDOOR AIR QUALITY SENSORS:

- CO_2 and mixed-gas sensors - room mounted
  - Ensure that the sensor is located in a representative location, e.g. on an open wall 1.5 to 3 m above the floor.
  - Ensure that the sensor is not mounted in niches or bookshelves or behind curtains.
  - Ensure that the sensor is not located where people are continuously present (within 1 or 2 metres).
- CO_2 and mixed-gas sensors - duct mounted
  - Ensure that the sensor is located in the return air duct as close as possible to the room extract point(s).
  - Ensure that the sensor is located in the vertical position.
  - Ensure the correct orientation of the duct probe with respect to the airflow.
  - Ensure that the sensor is not installed in a vertical position with the head at the bottom.

320.170 ACTUATORS:

- Securely mount actuators to rigid members, free from vibration or distortion in accordance with manufacturer's recommendations. Select mounting positions to require minimum linkages, and to avoid angular drive to operating levers. Allow access for servicing and replacement.
- Ensure that actuators and linkages for valves and dampers operate smoothly from fully open to fully closed without binding and with adequate torque to overcome the resistance of the actuator mechanism and the flow and to provide the specified close off ratings.
- Ensure that linkages are clearly marked with the clamping position such that after maintenance or replacement the mechanism is able to operate correctly.
- Fit actuators with visual position indication.
- Actuators shall have tamper-proof reversible clockwise and anti-clockwise mode selection.
- Ensure that there is sufficient space above the actuator so that it may be removed for testing or maintenance.
- Include position feedback devices suitable for connection to the BMS.
- Ensure that actuators incorporate a disconnection device to allow manual operation of the valve or damper in the event of actuator failure.
- Ensure that actuators are electrically and mechanically protected from the effects of valve or damper seizure.
- Use 24V actuators wherever possible. Where line voltage actuators are used, provide local means of isolation by manual isolator or plug and socket connection.
- Ensure that, during commissioning, valve actuators are fitted in a fully closed/bypass position where they are being fitted to valves which push against a spring.

320.180 VALVES:

- General
    - Ensure that valves have the correct authority without excessive pressure drop.
    - Ensure that valve bodies are suitable for the medium, the temperature and the pressure of the fluid system.
    - Ensure control valves have a close-off pressure rating higher than the circuit pressure design.
    - Ensure that valves will pass the required flow at a pressure drop within the maximum differential pressure rating of the valve.
    - Check for out-of-balance forces, particularly during operation of a three-port valve.
    - Where possible ensure that valves are not installed with their spindles in the horizontal position. If valves cannot be installed with their spindles in the vertical position ensure that they are as near as possible to the vertical.
    - Ensure that valves are not installed with the actuator at the bottom.
- Modulating valves
    - The following additional considerations apply for modulating valves:
    - Ensure system operating pressures, test pressures, pump heads and pressure drops through heat exchangers and associated pipework are known before control valves are selected.
    - Select valves to provide an authority of 0.3 to 0.5 for diverting applications and 0.5 for mixing applications.
    - Select valves with port characteristics appropriate for the intended function.
    - Ensure that all modulating control valves are selected for equal percentage or linear characteristics according to system type, to provide near linear characteristics between the valve position and heating/cooling power as delivered to the air or water-based system.
    - Ensure that the range ability of the selected valves is large enough to provide stable control under low load conditions.

320.190 VALVE SIZING REQUIREMENTS:

- All types of valves and applications
    - Parameter - Body pressure rating.
    - Requirements - To exceed system test pressure.
- All 2-port valves
    - Parameter - Close-off pressure rating.
    - Requirements - To exceed pump or system full differential pressure.
- All 3-port valves
    - Parameters - Close-off pressure rating.
    - Requirements - To exceed out of balance pressures
- All types of valves and applications
    - Parameters - Maximum leakage coefficient.
    - Requirements - 0.05% kv.
- 2-port isolation valves
    - Parameters - Pressure drop at full flow.
    - Requirements - Select at line size for minimal pressure drop.
- 2-port modulating valves
    - Parameters - Pressure drop at full flow.
    - Requirements - Select kv value for pressure drop within an agreed range.
- 3-port modulating valves
    - Parameters - Pressure drop at full flow.
    - Requirements - Select kv value for 30% - 50% authority against coil or circuit pressure drop.
- Isolation valve
    - Parameter - Characteristic.
- Modulating valves (plant valves and zone reheater coil valves)
    - Parameters - Characteristic.
    - Requirements - Equal percentage.
- Modulating valve (fan coil units)
    - Parameters - Characteristic.
    - Requirements - Equal percentage (preferred) or linear.
- Modulating valves (independently pumped mixing and injection circuits)
    - Parameter - Characteristic.
    - Requirements - Linear
- Pressure-independent control valve (PICV's)
    - Parameters - characteristics.
    - Requirements
        - Linear (modulating) or equal percentage (modulating).

320.200 DAMPERS:

- Provide visual position indicators on all damper actuators installed so that they can be seen from the plant room floor.
- Ensure that damper characteristics are as linear as possible.
- Ensure that modulating dampers are sized correctly to give adequate authority.
- Damper actuators shall have tamper-proof clockwise and anti-clockwise mode selection.

320.210 COMMUNICATION NETWORKS - GENERAL:

- Ensure that all addressable control devices can be addressed over the communications network.
- Ensure that the bandwidth and subsequent speed of communications is sufficient to meet the requirements of the selected manufacturer's BMS equipment.
- Ensure that no cross corruption of data occurs when the BMS shares a communication network with other IT-based systems. Ensure that permission has been given by the IT manager to connect BMS components onto the IT network. Comply with the organisation's IT strategy for connection of devices to the IT data network, including allocation of IP addresses.
- Ensure that network testing, identification and documentation comply with BS EN 50173-services and BS EN 50174-series.
- Ensure that all network devices such as routers and bridges are compatible with the network and are capable of operating such that the required throughput of data is achieved.
- Install communication networks in accordance with BS EN 61918.
- Assess the network performance for business-critical functions in accordance with BS EN 61907.

320.220 COMMUNICATION NETWORKS - STRUCTURED CABLING:

- Ensure that the selected BMS components are suitable for operating on the structured cabling system.
- Ensure that the selected BMS topology (star wired, chained or bus-based) is appropriate for the structured cabling system.
- Ensure that each addressable BMS device can be addressed over the structured cabling system.
- Where BMS components are specified to be powered from the structured cabling system ensure that the power available is sufficient. Ensure that overheating of the structured cabling system will not occur.
- Ensure that any changes to the structured cabling system are reflected in updated documentation.

320.230 COMMUNICATION NETWORKS - INTRANET AND INTERNET APPLICATIONS:

- Ensure that the BMS devices to be directly connected onto the Intranet/Internet are TCP/IP compatible.
- Ensure that the BMS is compatible with relevant security techniques in accordance with BS ISO/IEC 27032.

320.240 COMMUNICATION NETWORKS - MAINS-BOURNE SIGNALLING:

- Comply with the requirements of BS EN 50065-1.
- Provide the necessary equipment to ensure that there is no mutual interference between the signalling system of the electricity utility and mains-borne signalling of the BMS.
-
- Ensure that the attenuation of radio signals does not hinder effective data communications.

320.260 INTEGRATION WITH FIRE DETECTION SYSTEMS - GENERAL:

- Application: Monitoring
- Ensure approval from the relevant Fire Prevention Officer or Building Control Officer.
- Ensure that the requirements of BS 5839-1 are not compromised.
- Ensure that the fire detection system can operate autonomously and will not be affected by any failure of the BMS.
- Ensure that the BMS will not be affected by any failure of the fire detection system or fails safe as appropriate.
- Ensure that the loss of electrical power to the BMS will have no adverse effects on the fire detection system.
- Ensure that a full cause and effect testing programme is developed in conjunction with the fire alarm company.
- Ensure that the integrated system is fully commissioned.
- Ensure that the contractual responsibilities of the various parties responsible for the integrated system are fully defined.

320.270 INTEGRATION WITH FIRE SYSTEMS - INTEGRATION DETECTION FOR MONITORING:

- Application: Monitoring
- Unidirectional systems
    - Provide building graphics/schematics on the BMS operator client indicating the location of fire detector heads or zones, along with their respective status.
- Monitoring interface:
    - Digital input for AC or DC 24 V volt-free contacts
    - Communications protocol
        - BS EN 61158-2 (fieldbus)
        - Profibus (BS EN 62769-series)
        - Profinet (BS EN 62769-series)
        - Modbus
        - Modbus over Ethernet
        - KNX (BS ISO/IEC 14543-series)
        - BS EN ISO 1648-5 (BACnet)
- Ensure that a fire alarm condition automatically displays the appropriate building graphic/schematic along with relevant detector head status or zone status.
- Ensure that any time delay in receiving fire alarm data at the operator client does not exceed 2 seconds.

320.310 INTEGRATION WITH LIGHTING CONTROL SYSTEMS:

- Application: Monitoring and Control
- Ensure that the following functionality is provided:
    - Switching of lighting zones in accordance with zone occupation times as set on the BMS.
    - Switching of lighting zones in accordance with occupancy sensing and light level sensing where this is provided by the BMS.
    - Monitoring of lighting zones.
    - Monitoring of lamp run hours.
    - Raising of an alarm on lamp run hours exceeding the specified maximum.
    - The ability to override zones.

- Ensure that re-definition of zones cannot be performed via the BMS.
    - Direct interoperability
    - Gateway link
- Interface:
    - Digital input for AC or DC 24 V volt-free contacts
    - Communications protocol
        - Modbus
        - Modbus over Ethernet
        - KNX (BS ISO/IEC 14543-series)
        - BS EN ISO 1648-5 (BACnet)

330.330 CONTROLS CIRCUITS:

- Supply Voltage
    - Ensure control circuits are DC (negative-earth) or AC **[230]** V sourced from common single-phase supply. Control circuits from single-phase supplies derived from different phases shall not be used in the same enclosure.
- Circuit Voltage
    - Where control circuits are taken outside the panel
    - Use 24 volt operating supply.
    - Use **[230]** volt operating supply.

330.340 CONTROL CIRCUITS TRANSFORMERS:

- Provide control circuit transformers to supply power at voltages to suit control components.
- Standard
    - Use transformers in accordance with BS EN 61558-2-9, BS EN 61558-2-23 or BS EN 61558-1 and provide an external label of approved type and size.
- Protection - Primary and secondary fuses.

340.000 WORKMANSHIP:

340.010 GENERAL:

- Install pipeline control components in accordance with manufacturer's instructions.
- Install ductline control components in accordance with DW/144 and manufacturer's instructions.
- Install control components in accordance with manufacturer's recommendations, in positions indicated.

340.020 APPEARANCE:

- Arrange, support and clip all control wiring, pneumatic tubes and capillaries to present a neat appearance, with other services and the building structure.

340.030 INSULATION:

- Where control components are incorporated in insulated pipelines, ductlines or equipment, provide details for approval of method proposed to insulate component.

340.040 SUPPORTS:

- Arrange supports for control components to ensure no strain is imposed on components.

340.050 ACCESS:

- Arrange control components to ensure adequate access for operation and maintenance.
- Comply as relevant with BS EN 547-series and BS 7671 (IET Wiring Regulations) requirements for maintenance gangways.

340.080 POWER OPERATED CONTROLS:

- Install power operated controls in accordance with manufacturer's instructions and relevant standards.

340.110 ANCILLARIES:

- Install ancillaries in accordance with manufacturer's instructions.

340.120 ENCLOSURES:

- Install enclosures where indicated and where required, providing space for access and maintenance.

340.130 BUILDING MANAGEMENT SYSTEM INSTALLATION:

- Install commission and set to work building management system in accordance with the manufacturer's recommendations.

340.140 BUILDING MANAGEMENT SYSTEM CABLE INSTALLATION:

- Plan and install all building management monitoring systems cables in accordance with the cable manufacturer's recommendations.
- Label and record all monitoring cables in accordance with:
    - Approved Cable schedules
    - Approved Shop drawings

340.150 BUILDING MANAGEMENT SYSTEM QUALITY CONTROL:

- Handle, store and install equipment and components of the building management system in accordance with the manufacturer's recommendations.
- Inspect all equipment and components on delivery, before fixing and after installation and reject and replace any which are defective.
- Record all commissioning tests and site modifications to hardware or software, and revise operating and maintenance instructions accordingly.
- Inspect installed and operational functions of Building Automation, Controls and Technical Building Management System including its configuration in accordance with BS EN 16946-1.
- Manage configuration of software, settings, data and design, in accordance with an appropriate Configuration Management Plan complying as necessary with BS EN ISO 9001, BS ISO 10007, BS ISO/IEC 12207 and BS ISO/IEC/IEEE 15288.

- Provide configuration details along with the operation and maintenance manual on handover.
- Manage information security systems, software and data during design, implementation and commissioning in line with BS EN ISO/IEC 27001.

340.160 CONTROL SYSTEM FUNCTION CHARTS:

- Prepare function charts for the control system in accordance with BS EN 60848. Obtain approval for function chart before design of system hardware or writing control software.
- Function chart format.
    - Combined function chart/circuit diagram.
    - Function chart only.

350.000 COMMISSIONING

- Perform system commissioning in accordance with CIBSE Commissioning Code C.
- Undertake and manage integrated commissioning in accordance with CIBSE Commissioning Code M: Commissioning Management
    - Performance interface testing with all other logically-connected systems
    - Perform whole building integrated testing
    - Perform black building integrated testing
- Carry out seasonal commissioning during four separate occasions with three monthly intervals during the defects liability period in the first year after handover.

360.000 DEMONSTRATION AND HANDOVER

360.010 WITNESSING REQUIREMENTS:

- Ensure that the project supervisor's nominated representative implements the following witnessing requirements. Ensure that on-site commissioning staff facilitate the witnessing process.
- Ensure that the BMS hardware is installed in accordance with the specification.
- Verify any operator software and associated graphics.
- Witness completely the control of any main and/or critical items of plant along with a random sample of other points.
- If less than 300 points, witness all points. Between 300 and 1,000 points witness 50% (minimum of 300 to be witnessed). If more than 1,000 points witness 20% (with a minimum of 500 points witnessed).
- Reserve the right to witness 100% of the points if the failure rate is greater than 5%.
- Witness a sample of specific functions, e.g. 10% of alarms and 10% of data logging.
- Witness one of several identical items of plant in detail with the others witnessed on a random basis.
- Verify the system security access.
- Verify that all safety-related functions perform to that specified, e.g. plant shutdown on fire condition.
- Verify all plant restarts according to that specified after building power failure and local power failure.
- Witness all power meter data-points to ensure that they match the meters.
- Ensure that trend logs are used when witnessing points in order to monitor the performance of control actions.
- Verify the handover of all operating manuals and system documentation.
- Verify the handover of backup copies of software.

- Verify the completion of any specified system operator training.

360.020 OPERATOR TRAINING:

- Ensure that training is completed before the BMS is handed over.
- Ensure that each trained operator signs a training acceptance certificate(s).
- Provide training off-site at the BMS suppliers training facility. Complement this off-site training with 'hands on' on-site training.
- Provide appropriate reference and training manuals for the operator.
- Provide operator training for one or more, as per the employer requirements, of the following levels of operator.
- Basic operator
    - Ensure that the operator is trained to:
        - Call up and view point-data from plant schematics and/or points lists
        - Acknowledge system alarms
        - View trend logs
- Intermediate operator
    - In addition to the requirements for a Basic operator, ensure that the operator is trained to make basic alterations to the BMS including changes to:
        - Time and occupancy programmes
        - Control set-points
        - Setting up trend logs
        - Setting up alarm routines
        - Ensure that the operator is also trained for testing and routine inspection of sensors and actuators
- Advanced operator
    - In addition to the requirements for an intermediate operator, ensure that the operator is trained to:
        - Add or change graphics/schematics
        - Change control strategies
        - Add analogue and digital inputs/outputs to the system
        - Back-up the system and archive logged data
        - Re-load system software/configuration details
        - Add/modify passwords/monitor system security

360.030 OPERATION AND MAINTENANCE MANUALS:

- Ensure that the O&M manual specified in the Employer's Requirements, includes the following and is included in the site health and safety file:
    - A written description of plant operation
    - Plant schematic arrangement of automatic controls drawing
    - Control strategy/logic diagrams recording the final version of configuration software installed at handover
    - Details of system application software configuration
    - A points list including hard and soft-points (all points should have a unique mnemonic)
    - A description of user adjustable points
    - Commissioning record details
    - Detailed data sheets for all control components and equipment

- Wiring circuit details including origin, route and destination of each cable
- Basic security access to the system
- Specific instructions for server shutdown and restart procedures
- Comprehensive instructions for switching on, operation, switching off, isolation, fault finding and procedures for dealing with emergency conditions
- Instructions for any precautionary measures necessary.
- Instructions for the routine operation of the control system including simple day-to-day guidance for those operating the control system with limited technical skill
- Instructions for servicing and system upkeep
- A provision for update and modification

- Ensure that the O&M manual includes comprehensive system operating instructions.

360.040 SOFTWARE:

- Ensure that a copy of the configuration software is securely held both on and off-site.
- Ensure that, as alterations are made to the configuration software, all previous versions of the software are securely archived.
- Ensure that all credentials are transitioned to the operation and maintenance organisation(s) at handover.

360.050 POST-HANDOVER CHECKS:

- Ensure that the following post-handover checks are performed:
  - Global level checks
    - Internal air temperature
    - Relative humidity
    - Ventilation
    - Energy consumption (ensure that the pulse-input counters match the meters).
    - Seasonal commissioning
    - Soft landings requirements
    - Check that each of the above meets the specified requirements.
  - System level checks
    - Control strategies. Check that any suspect control strategies are appropriate for the intended application. Check that the suspect control strategy has been implemented and commissioned correctly. Check that the control strategy is still appropriate for the intended use.
    - Network communications. Check that all relevant field controllers communicate properly. Check for correct sharing between controllers of relevant data and correct inter-controller operation.
    - Control set-points. Check that the set-points in question are correct and appropriate for the actual operating conditions.
    - Control loop settings. Check that the control loop settings result in accurate and stable control. Check that all self-learnt characteristics are valid.
    - Control zones. Check that the control zones are appropriate.
    - Occupant controls. Check that occupant controls work correctly.
  - Sub-system/component level checks
    - Sensors. Check the accuracy and location of any suspect sensors.
    - Actuators. Check that any suspect actuators operate correctly.

- Dampers and valves. Check that any suspect dampers and valves are not jammed and that they operate as intended.

W71 – COMMON CLAUSES FOR STRUCTURED CABLING (EN)

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. Section includes general communications design requirements, administration topics, and installation for Information and Communications Technologies (ICT) cabling infrastructure.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. To be developed

B. Referenced Standards

1. International British (BS), European (EN) and IEC Standards

C. Codes and Standards: All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. EN 50173-1, Information technology – Generic cabling systems– General requirements.
2. EN 50173-2, Information technology – Generic cabling systems – Office premises.
3. EN 50173-3, Information technology – Generic cabling systems – Industrial premises.
4. EN 50173-4, Information technology – Generic cabling systems – Homes.
5. EN 50173-5, Information technology – Generic cabling systems – Data centres.
6. EN 50173-6, Information technology – Generic cabling systems – Distributed building services.
7. CLC/TR 50173-99-1, Cabling guidelines in support of 10 GBASE-T.
8. EN 50174-1, Information technology – Cabling installation – Installation specification and quality assurance.
9. EN 50174-2, Information technology – Cabling installation – Installation planning and practices inside buildings.
10. EN 50174-3, Information technology – Cabling installation – Installation planning and practices outside buildings.
11. CLC/TR 50174-99-1, Information technology - Cabling installation - Remote powering.
12. EN 50310, Application of equipotential bonding and earthing in buildings with information technology equipment.
13. EN 50346, Information technology – Cabling installations – Testing of installed cabling.
14. EN 61935-1, Specification for the testing of balanced and coaxial information technology cabling. Installed balanced cabling as specified in the standards series EN 50173.
15. ISO/IEC TR 14763-2-1, Information technology – Implementation and operation of customer premises cabling – Part 2-1: Planning and installation – Identifiers within administration systems.
16. ISO/IEC 14763-3, Information technology – Implementation and operation of customer premises cabling – Part 3: Testing of optical fibre cabling.
17. EN 61073-1, Fibre optic interconnecting devices and passive components — Mechanical splices and fusion splice protectors for optical fibres and cables — Part 1: Generic specification
18. Local regulations and standards, where enforced and relevant, are to have precedence over the Standards.

110.020 PROJECT/SITE CONDITIONS

1. To be developed

110.030 DEFINITIONS AND ABBREVIATIONS

A. Definitions: To be developed

B. Abbreviations: To be developed

120.000 SYSTEM DESCRIPTION

120.010 SCOPE OF WORK

A. To be developed

120.020 SYSTEM ARCHITECTURE

A. To be developed

B. The objective of this Project is to provide a complete communications structured cabling infrastructure system installation including, but not limited to: fiber optic backbone, horizontal cabling with associated terminations, mounting equipment, cable pathway and management systems, testing and other items/materials

C. The Structured Cabling Solution shall be designed and installed to provide the telecommunications infrastructure (patch panels, frames, patch cords, cables, faceplates and outlets) which will function for a multimedia communications solution.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Refer to Refer to Division W, Section “Common Clauses for IT & Security Systems”

for general requirements.

PART 3 PRODUCTS AND WORKMANSHIP

300.000 PRODUCTS

300.010 MANUFCATURERS

A. To be developed

310.000 QUALITY MANAGEMENT

310.010 PRODUCTS AND WORK BY OTHERS / COORDINATION

A. To be developed

310.020 CONFIDENTIALITY

A. To be developed

310.030 QUALITY ASSURANCE

A. To be developed

310.040 DELIVERY, STORAGE AND HANDLING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

310.050 WARRANTY

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

310.060 MAINTENANCE AND SUPPORT

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

310.070 SPARE PARTS AND EXTRA MATERIAL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

320.000 SUBMITTALS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

330.000 EXECUTION

330.010 EXAMINATION

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

330.020 MEASUREMENT PROCEDURES

A. To be developed

330.030 PREPARATION

A. To be developed

330.040 INSTALLATION

A. To be developed

B. Pull Strings

C. Pathway Fill

D. Separation / Segregation of Services

E. Firestopping Procedures

F. Grounding

1. To be developed
2. Install grounding according to EN 50310, EN 50174-2 and EN 50174-3.

G. Labeling

1. Comply with Division W, Section “Identification for Communications Systems (EN)”.

330.050 FIELD QUALITY CONTROL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

330.060 CLEANING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

330.070 DEMONSTRATION AND TRAINING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

W71A – IDENTIFICATION FOR COMMUNICATIONS SYSTEMS (EN)

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. Section includes requirements for the identification of the various components of the telecommunications infrastructure and pathway system.

B. Works covered by this Section shall consist of furnishing labor, equipment, materials and software necessary for the labeling of the telecommunications infrastructure as required by these Specifications.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed.

110.020 PROJECT/SITE CONDITIONS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

110.030 DEFINITIONS AND ABBREVIATIONS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed.

120.000 SYSTEM DESCRIPTION

120.010 SCOPE OF WORK

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Related Sections: To be developed.

PART 3 TO BE DEVELOPED.PRODUCTS AND WORKMANSHIP

300.000 PRODUCTS

300.010 MANUFACTURERS : TO BE DEVELOPED.

300.020 CABLE MANAGEMENT SYSTEM

300.030 LABELING GENERAL REQUIREMENTS

A. All components of the telecommunications infrastructure and pathway system shall be labeled according to the applicable Standard and the adopted ‘System Administration Scheme’ described herein and in coordination with the Employer and Engineer, including but not limited to:

1. Copper and fiber optic cables and patch cords.
2. Workstation outlets faceplates and Individual outlet connectors.
3. Termination panels, blocks, trays.
4. Telecommunications Room entry and exit pathways.
5. Racks, cabinets, and equipment.
6. Fiber optic on either side of the splice closure.
7. Grounding and bonding system for telecommunications.
8. OSP manholes / pull boxes covers.
9. Telecommunications cable tray and conduit pathways.

B. Labels shall provide a direct link to the identifier within the record within the administration system.

C. Labels shall be machine-manufactured by a labeling machine. Handwritten labels will not be accepted for final labeling.

D. Labels shall meet the following legibility and adhesion requirements:

E. Labels should be resistant to the environmental conditions at the point of installation (such as moisture, heat, or ultraviolet light), and should have a design life equal to or greater than that of the labeled component.

F. Labels shall be accessible and, where necessary, able to be modified.

G. Cable Labels: Self-adhesive vinyl or vinyl-cloth wraparound tape markers, machine printed with alphanumeric cable designations.

H. Flat-surface labels: Self-adhesive vinyl or vinyl-cloth labels, machine printed with alphanumeric designations.

I. To be developed.

300.040 AUTOMATED INFRASTRUCTURE MANAGEMENT (AIM)

A. Overview : To be developed.

B. Software Characteristics for the AIM shall be developed

C. Hardware Characteristics for the AIM shall be developed

310.000 QUALITY MANAGEMENT

310.010 MISCELLANEOUS QUALITY MANAGEMENT TOPICS

A. For the following quality management topics, refer to Division W, Section “Common Clauses for Structured Cabling (EN)”:

1. PRODUCTS AND WORK BY OTHERS / COORDINATION
2. CONFIDENTIALITY
3. QUALITY ASSURANCE
4. DELIVERY, STORAGE, AND HANDLING
5. WARRANTY
6. MAINTENANCE AND SUPPORT
7. SPARE PARTS AND EXTRA MATERIAL

320.000 SUBMITTALS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

330.000 EXECUTION

330.010 EXAMINATION

A. To be developed.

330.020 SYSTEM ADMINISTRATION SCHEME

A. Comply with EN 50174-1 and ISO/IEC TR 14763-2-1 for system administration scheme.

B. EN 50174-1 and ISO/IEC TR 14763-2-1 Administration Scheme.

1. To be developed.

330.030 GENERAL REQUIREMENTS

A. To be developed

B. Cable Schedule

C. Cabling Administration Drawings

D. Cable and Wire Identification:

1. To be developed

E. Labels shall be pre-printed or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in EN 50174-1

1. Labels that snap-around or slip-around the cable/raceway shall be flexible vinyl or polyester labels that flex as the cable/raceway is bent.
2. To be developed.

330.040 RE-INSTALLATION

A. To be developed

330.050 CLOSEOUT ACTIVITIES

A. Contractor to submit for PC-based, cabling administration system - as detailed in Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed.

330.060 DEMONSTRATION AND TRAINING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

W71B - COMMUNICATIONS EQUIPMENT ROOM FITTINGS (EN)

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. Section Includes:

1. Telecommunications equipment racks and cabinets.
2. Telecommunications mounting elements.
3. Rack mounted power protection and power strips.
4. Rack mounted uninterruptible power supplies (UPS).
5. Backboards.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

110.020 PROJECT/SITE CONDITIONS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

110.030 DEFINITIONS AND ABBREVIATIONS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Definitions: To be developed.

120.000 SYSTEM DESCRIPTION

120.010 SCOPE OF WORK

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

120.020 COMMUNICATIONS ROOMS GENERAL REQUIREMENTS

A. To Be Developed.

B. Comply with EN 50174-2 for the particular type of premises

C. Check provisions of communications rooms for conformance to the general requirements. Any discrepancy shall be brought to the attention of the Engineer immediately.

D. Communications rooms must be dedicated to designated equipment and services only:

E. Space shall not be used for storage of equipment not related to designated equipment and services.

F. Hazardous or corrosive materials shall not be stored in the space.

G. Piping, ductwork and distribution of power, not related to designated equipment and services shall not pass through or be located within the space.

H. Spaces intended to contain metallic cabling shall be located away from sources of electromagnetic interference. Examples of such noise sources include electrical power supply transformers, motors and generators, x-ray equipment and radio or radar transmitters.

I. Each communication room shall be equipped with fire detection, fire-extinguishing system and prevention devices

J. Contractor shall ensure that foreign piping such as water pipes, HVAC ducts, and other unrelated systems utilized for or containing liquids, or gases are not installed or do not pass through telecommunication rooms. Sprinkler piping shall not pass through the telecommunications space to serve

other areas. Sprinkler piping serving only telecommunications spaces shall not be considered foreign to the telecommunications installation.

K. AC grade plywood as per APA “American Plywood Association”

L. A minimum of three walls shall be covered with AC-grade plywood backboards starting from 300 mm AFF (smooth side to interior of room mounted vertically), capable of supporting mounted hardware and equipment. Fire-treatment verification stamps on plywood shall be left unpainted to be readable.

M. Communications room walls shall extend from floor slab to ceiling deck, with a clear height not less than 3 meters and with no drop ceilings (false ceilings) installed to allow the installation of high-level or ceiling-mounted pathway systems.

N. Cable trays or ladder racks shall be used to distribute cables between rooms through finished wall penetrations.

O. All penetrations through fire-rated building elements (walls and floors) shall be sealed with an approved fire-stopping system. Riser openings, sleeves, cables, conduits, cable trays, and raceways, etc. shall be properly fire stopped.

P. Floors shall have anti-static properties.

Q. Communications rooms with frames or cabinets that are to be cabled from below, shall be provided with access floor (raised floor) systems of sufficient under-floor depth to enable routing of underfloor pathway systems and other underfloor services.

R. Communications rooms shall have only one lockable entrance door, with dimensions not less than 1000mm wide and 2130mm in height, that opens towards the outside of the room, and does not open into another room.

S. Doors shall be provided with a lockset for the appropriate technology key with pinned hinges and anti-pry guards.

T. Door shall not have a door sill.

U. Door shall not have a center post to facilitate access for large equipment.

V. Environmental Conditions: To be developed.

W. Floor loading capacity: To be developed.

X. Plumbing: To be developed.

Y. Electrical: To be developed.

Z. Earthing and Lightning Protection: To be developed.

AA. Labeling: Refer to Division W, Section “Identification for Communications Systems (EN)”.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed.

PART 3 PRODUCTS AND WORKMANSHIP

300.000 PRODUCTS

300.010 MANUFACTURERS

A. To be developed.

300.020 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated.

B. To be developed.

300.030 EQUIPMENT RACKS AND CABINETS

A. General Requirements:

1. Freestanding and wall-mounting, modular-steel and/or aluminium units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Module Dimensions: Width compatible with EIA/ECA-310-E standard.
3. To be developed as per design requirements

B. Floor-Mounted Racks – 2 Post Relay Racks: Modular-type, steel or aluminum construction.

1. To be developed as per design requirements

C. Floor-Mounted Racks – 4-Post Server Frame: Modular-type, steel or aluminum construction.

1. To be developed as per design requirements

D. Modular Freestanding Server Cabinets, steel or aluminum:

1. To be developed as per design requirements

E. Modular Freestanding Network Cabinets, steel or aluminum:

1. To be developed as per design requirements

F. Modular Wall Cabinets:

1. To be developed as per design requirements

G. Cable Management for Equipment Frames:

1. To be developed as per design requirements

300.040 POWER STRIPS

A. Power Strips in free-standing cabinets:

1. Vertical mounting.
2. To be developed as per design requirements

B. Power Strips in wall-mounted cabinets:

1. Horizontal, rack-mounting.

1. To be developed as per design requirements

300.050 INDIVIDUAL RACK MOUNTED UNINTERRUPTIBLE POWER SUPPLIES (UPS) FOR RATINGS UP TO 3 KVA

A. Provide rack mounted UPS units for telecommunication/security active equipment.

B. UPS shall comply with: EN 62040-1 (Safety) and EN 62040-2 (EMC: Category C2).

C. Technical Characteristics:

1. To be developed as per design requirements

300.060 GROUNDING

A. To be developed.

B. Comply with EN 50310, EN 50174-2 and EN 50174-3.

300.070 LABELING

A. Comply with Division W, Section “Identification for Communications Systems (EN)”.

B. Comply with EN 50174-1.

310.000 QUALITY MANAGEMENT

310.010 PRODUCTS AND WORK BY OTHERS / COORDINATION

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

310.020 MISCELLANEOUS QUALITY MANAGEMENT TOPICS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

310.030 SPARE PARTS AND EXTRA MATERIAL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

320.000 SUBMITTALS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

330.000 EXECUTION

330.010 ENTRANCE FACILITIES

A. Contact telecommunications Service Provider and arrange for installation of demarcation point, protected entrance terminals, and an enclosure when so directed by the Service Provider.

B. To be developed.

330.020 INSTALLATION

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

330.030 FIRESTOPPING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Comply with EN 50174-1.

C. To be developed.

330.040 GROUNDING

A. To be developed.

B. Install grounding according to EN 50310, EN 50174-2 and EN 50174-3.

330.050 IDENTIFICATION

A. Comply with requirements specified in Division W, Section "Identification for Communications Systems (EN)".

B. Identify system components, wiring, and cabling complying with EN 50174-1.

C. To be developed.

330.060 FIELD QUALITY CONTROL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

330.070 DEMONSTRATION AND TRAINING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

W71C - COMMUNICATIONS BACKBONE CABLING (EN)

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. Section Includes:

1. Optical fiber cabling.
2. Balanced copper (metallic) twisted pair cabling.
3. Cable connecting hardware, patch panels, and cross-connects.

100.020 PERFORMANCE REQUIREMENTS

A. Backbone cabling system shall comply with both environmental and transmission performance criteria stated in Division W, Section "Common Clauses for IT & Security Systems" in accordance with EN 50173-1, when tested according to test procedures of the relevant Standards.

B. Standard cables shall have a flame retardant overall sheath complying with IEC 60332-1-2.

C. Low Smoke Zero Halogen (LSZH/LS0H) cables shall comply with the following standards:

1. Flame retardant: IEC 60332-1.
2. Halogen-free according to:

a) IEC 60754-1 for amount of halogen acid gas.
b) IEC 60754-2 for corrosiveness of combustion gases according to (degree of acidity).

3. Low smoke density according to IEC 61034-2.

D. Fire resistant cables shall comply with the following standards:

1. Circuit Integrity: IEC 60331-23 (metallic cables); IEC 60331-25 (fiber optic cables).
2. Flame retardant: IEC 60332-1-2.
3. Halogen-free according to:

a) IEC 60754-1 for amount of halogen acid gas.
b) IEC 60754-2 for corrosiveness of combustion gases according to (degree of acidity).

4. Low smoke density according to IEC 61034-2.

E. Cable Connecting Hardware shall be compatible for use with the Automated Infrastructure Management (AIM) system of the Project.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Refer to Division W, Section "Common Clauses for IT & Security Systems".

B. Standards relevant to optical fiber cables mechanical and environmental requirements include:

1. EN 60793-2, Optical fibres. Product specifications. General.
2. EN 60793-2-10, Optical fibres. Product specifications. Sectional specification for category A1 multimode fibres.
3. EN 60793-2-50, Optical fibres. Product specifications. Sectional specification for class B single-mode fibres.
4. EN 60794-1-1, Optical fibre cables. Generic specification – General.
5. EN 60794-2, Optical fibre cables. Indoor cables. Sectional specification.
6. EN 60794-2-11, Optical fibre cables. Indoor optical fibre cables. Detailed specification for simplex and duplex cables for use in premises cabling.
7. EN 60794-2-21, Optical fibre cables. Indoor optical fibre cables. Detailed specification for multi-fibre optical distribution cables for use in premises cabling.
8. EN 60794-3, Optical fibre cables. Sectional specification. Outdoor cables.

9. EN 60794-3-12, Outdoor cables. Detailed specification for duct and directly buried optical telecommunication cables for use in premises cabling
10. EN 60794-3-21, Optical fibre cables. Outdoor cables. Detailed specification for optical self-supporting aerial telecommunication cables for use in premises cabling.

110.020 PROJECT/SITE CONDITIONS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

110.030 DEFINITIONS AND ABBREVIATIONS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Definitions

1. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. Abbreviations

1. To be developed.

120.000 SYSTEM DESCRIPTION

120.010 SCOPE OF WORK

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

120.020 BACKBONE CABLING DESCRIPTION

A. Backbone cabling system for a generic Information and Communications Technology (ICT) cabling system shall include two subsystems: “Campus Backbone” and “Building Backbone” as described in Division W, Section “Common Clauses for Structured Cabling (EN)”.

B. Backbone cabling system shall also include Data Centers Backbone for Network access system and Main distribution system – as applicable to the Project – and described in Division W, Section “Common Clauses for Structured Cabling (EN)”.

C. Each cabling subsystem consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

D. Backbone cabling cross-connects may be located in equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. General

1. Refer to Division W, Section W71 “Common Clauses for Structured Cabling (EN)”.

B. Related Sections: To be developed

PART 3 PRODUCTS AND WORKMANSHIP

300.000 PRODUCTS

300.010 MANUFACTURERS

1. To be developed

300.020 PATHWAYS

A. Comply with requirements in Division Y Sections:
    1. To be developed
B. Comply with requirements in EN 50174-2 and EN 50174-3.

300.030 OPTICAL FIBER CABLE

A. Optical Fiber Cable - For Indoor Use:
    1. Tight buffered, optical fiber cable:
        a) Single-Mode and Lase Optimized Multi-Mode
        b) Non -conductive construction.
        c) Reinforcement:
            1) Central strength element aramid / glass fiber
            2) Aramid / glass fiber yarn around the sub-units of fibers
        d) PVC inner sheath.
        f) PVC sheath with color to designate the type of optical fiber and ripcord applied longitudinally underneath.
    2. Standards: Comply with:
        1) EN 60794-2
        2) EN 60794-2-11
        3) EN 60794-2-21
B. Optical Fiber Cable - For Indoor/Outdoor Use:
    1. Application: indoor/outdoor fiber optic cables are intended to be used to make interconnections within and between adjacent buildings or to the first outdoor splice point. These cables shall be fully resistant to the typical outside plant environment, but also can be routed indoors, where flame rating requirements apply.
    2. Tight-buffered using dry water blocking technology, optical fiber cable:
        a) Single-Mode and Laser Optimized Multi-Mode
        b) Conductive construction.
        c) Reinforcement:
            1) Central strength element aramid / glass fiber yarn.
            2) Aramid / glass fiber yarn around the sub-units of fibers
        d) PVC inner sheath.
        e) Steel tape armour.
            1) The cable shall be spirally wrapped and encased within an interlocking or corrugated armored metal without interruption from end to end for protection and strength.
        f) PVC outer sheath with color to designate the type of optical fiber and ripcord applied longitudinally underneath.
        g) Additional Polyamide/ Nylon sheath for protection against rodents and termites.
    3. Standards: Comply with:
        1) EN 60794-2
        2) EN 60794-2-11
        3) EN 60794-2-21
C. Optical Fiber Cable - For Outdoor Use (Outside Plant):
    1. Jell-filled loose tube optical fiber cable.
        a) Single-Mode or Laser Optimized Multi-Mode
        b) Conductive construction.

c) Reinforcement:

1) Central strength element solid steel
2) Aramid / glass fiber yarn around the sub-units of fibers.

d) Polyethylene (PE) inner sheath.

e) Steel tape armour.

1) The cable shall be spirally wrapped and encased within an interlocking or corrugated armored metal without interruption from end to end for protection and strength.

f) Polyethylene (PE) outer sheath with color to designate the type of optical fiber and ripcord applied longitudinally underneath.

g) Additional Polyamide/ Nylon sheath for protection against rodents and termites.

2. Standards: Comply with:

1) EN 60794-3
2) EN 60794-3-12
3) EN 60794-3-21

D. Optical Fiber Cable - Sheath

1. Cable cordage sheath, fiber, and group color shall be according to EN 50174-1.
2. To be developed as per design requirements

E. Number of Fiber Strands / Cores

1. To be developed as per design requirements

300.040 SINGLE-MODE OPTICAL FIBER CABLE - CATEGORY OS2

A. To be developed

300.050 LASER-OPTIMIZED MULTI-MODE OPTICAL FIBER CABLE - CATEGORY OM5

A. To be developed

300.060 OPTICAL FIBER CABLE HARDWARE

A. Optical Fiber Patch Bays

1. To be developed

B. Patch Cords

1. Patch Cords in lengths to suit application and routing requirements.

C. Cable Connecting Hardware:

1. Comply with EN 50173-1, Clause 8 for “Connecting Hardware Requirements”.

1. To be developed

300.070 OPTICAL FIBER FUSION SPLICING DEVICE

1. To be developed

300.080 BALANCED TWISTED PAIR COPPER CABLE

1. To be developed

300.090 BALANCED CABLE HARDWARE

A. General Requirements for Cable Connecting Hardware: Comply with EN 50173-1, Clause 8 for “Connecting Hardware Requirements”, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

B. To be developed

300.100 GROUNDING

A. To be developed

B. Comply with EN 50310, EN 50174-2 and EN 50174-3.

300.110 IDENTIFICATION PRODUCTS

A. Comply with Division W, Section "Identification for Communications Systems (EN)."

B. Comply with EN 50174-1.

300.120 CABLE MANAGEMENT SYSTEM

A. Comply with Division W, Section "Identification for Communications Systems (EN)" for cable and asset management software.

310.000 QUALITY MANAGEMENT

310.010 PRODUCTS AND WORK BY OTHERS / COORDINATION

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

310.020 CONFIDENTIALITY

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

310.030 QUALITY ASSURANCE

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

310.040 DELIVERY, STORAGE, AND HANDLING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

310.050 WARRANTY

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

310.060 MAINTENANCE AND SUPPORT

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

310.070 SPARE PARTS AND EXTRA MATERIAL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed.

320.000 SUBMITTALS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Cable Pulling Plan: To be developed

C. Splice Plan: To be developed

D. Cable Testing Plan: To be developed

E. Cable Testing Reports: To be developed

330.000 EXECUTION

330.010 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by the telecommunications Service Provider.

330.020 WIRING METHODS AND PATHWAYS

A. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division W, Section "Communications Equipment Room Fittings (EN)".

B. Comply with EN 50174-2 for pull-box sizing and length of conduit and number of bends between pull points.

C. Wiring Method: In raceways and cable trays.

D. To Be Developed.

330.030 INSTALLATION OF CABLES

A. General Requirements for Fiber Optic Backbone Cabling:

1. Comply with EN 50174-1, EN 50174-2 and EN 50174-3.
2. To be developed.

B. General Requirements for Balanced Twisted Pair Backbone Cabling:

1. Comply with EN 50174-1, EN 50174-2 and EN 50174-3.
2. To be developed.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. To be developed.

D. Installation of Cable Routed Exposed under Raised Floors:

1. To be developed.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Refer to Division W, Section “Common Clauses for IT & Security Systems”.
2. Comply with EN 50174-2 and EN 50174-3 recommendations for separating metallic communication cable from potential EMI sources, including electrical power lines and equipment.
3. To be developed

330.040 FIRESTOPPING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

C. Comply with EN 50174-1.

330.050 GROUNDING

A. To be developed

B. Install grounding according to EN 50310, EN 50174-2 and EN 50174-3.

330.060 IDENTIFICATION

A. Comply with requirements for identification specified in Division W, Section "Identification for Communications Systems (EN)".

B. Identify system components, wiring, and cabling complying with EN 50174-1.

330.070 CABLE MANAGEMENT SYSTEM

A. Comply with requirements in Division W, Section "Identification for Communications Systems (EN)" for cable and asset management software.

330.080 FUSION SPLICING DEVICE

A. To be developed

330.090 FIELD QUALITY CONTROL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

330.100 DEMONSTRATION AND TRAINING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

W71D - COMMUNICATIONS HORIZONTAL CABLING (EN)

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. Section Includes:

1. Twisted Pair (Balanced) cabling.
2. Optical fiber cabling.
3. Consolidation Points.
4. Cable connecting hardware, patch panels, and cross-connects.
5. Telecommunications outlets/connectors.

100.020 PERFORMANCE REQUIREMENTS

A. Horizontal cabling system shall comply with both environmental and transmission performance criteria stated in Division W, Section "Common Clauses for Structured Cabling (EN)" in accordance with EN 50173-1, when tested according to test procedures of the relevant Standards.

B. Standard cables shall have a flame-retardant overall sheath complying with IEC 60332-1-2.

C. Low Smoke Zero Halogen (LSZH/LS0H) cables shall comply with the following standards:

1. Flame retardant: IEC 60332-1.
2. Halogen-free according to:

a) IEC 60754-1 for amount of halogen acid gas.
b) IEC 60754-2 for corrosiveness of combustion gases according to (degree of acidity).

3. Low smoke density according to IEC 61034-2.

D. Fire-resistant data cables shall comply with the following standards:

1. Circuit Integrity: IEC 60331-23 (metallic cables); IEC 60331-25 (fiber optic cables).
2. Flame retardant: IEC 60332-1-2.
3. Halogen-free according to:

a) IEC 60754-1 for amount of halogen acid gas.
b) IEC 60754-2 for corrosiveness of combustion gases according to (degree of acidity).

4. Low smoke density according to IEC 61034-2.

E. Cable Connecting Hardware shall be compatible for use with the Automated Infrastructure Management (AIM) system of the Project.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Refer to Division W, Section "Common Clauses for IT & Security Systems".

B. Standards relevant to optical fiber cables mechanical and environmental requirements include:

1. EN 60793-2, Optical fibres. Product specifications. General.
2. EN 60793-2-10, Optical fibres. Product specifications. Sectional specification for category A1 multimode fibres.
3. EN 60793-2-50, Optical fibres. Product specifications. Sectional specification for class B single-mode fibres.
4. EN 60794-1-1, Optical fibre cables. Generic specification – General.
5. EN 60794-2, Optical fibre cables. Indoor cables. Sectional specification.
6. EN 60794-2-11, Optical fibre cables. Indoor optical fibre cables. Detailed specification for simplex and duplex cables for use in premises cabling.

7. EN 60794-2-21, Optical fibre cables. Indoor optical fibre cables. Detailed specification for multi-fibre optical distribution cables for use in premises cabling.
8. EN 60794-3, Optical fibre cables. Sectional specification. Outdoor cables.
9. EN 60794-3-12, Outdoor cables — Detailed specification for duct and directly buried optical telecommunication cables for use in premises cabling
10. EN 60794-3-21, Optical fibre cables. Outdoor cables. Detailed specification for optical self-supporting aerial telecommunication cables for use in premises cabling.

110.020 PROJECT/SITE CONDITIONS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

110.030 DEFINITIONS AND ABBREVIATIONS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Definitions

1. Consolidation Point (CP): A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.
2. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
3. Multiuser telecommunications outlet (MUTO): a grouping in one location of several telecommunications outlets/connectors.
4. Work Area: building space where the occupants interact with terminal equipment.
5. Telecommunications outlet (TO): fixed connecting device where the horizontal cabling terminates. The telecommunications outlet provides the interface to the Work Area cabling

C. Abbreviations : to be developed

120.000 SYSTEM DESCRIPTION

120.010 SCOPE OF WORK

A. To be developed.

120.020 HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.

1. EN 50173-2 requires that a minimum of two telecommunications outlets/connectors be installed for each Work Area.
2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
3. Bridged taps and splices shall not be installed in the horizontal cabling.
4. Splitters shall not be installed as part of the optical fiber cabling.

B. To be developed

C. The maximum allowable horizontal cable length is 90 m. This maximum allowable length does not include an allowance for the length of 5 m to the workstation equipment or in the horizontal cross-connect.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. General

1. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Related Sections: to be developed

PART 3 PRODUCTS AND WORKMANSHIP

300.000 PRODUCTS

300.010 MANUFACTURERS

A. To be developed

300.020 PATHWAYS

A. To be developed

B. Comply with requirements of EN 50174-2.

300.030 TWISTED PAIRS (BALANCED) CABLE

A. General Requirements: to be developed

B. Category 6_A balanced cables so as to support and exceed the channel transmission performance Class E_A of EN 50173-1.

C. Balanced F/UTP (FTP) Cable- Category 6_A - for Indoor Use: 100-ohm, 23 AWG copper conductor, to be developed as per design requirements

D. Balanced U/FTP (STP) Cable- Category 6_A - for Indoor Use: 100-ohm, 23 AWG copper conductor, to be developed as per design requirements

E. Balanced S/FTP (S-STP) Cable- Category 6_A - for Indoor Use: 100-ohm, 23 AWG copper conductor, to be developed as per design requirements

300.040 BALANCED CABLE HARDWARE

A. To be developed

300.050 OPTICAL FIBER CABLE

A. Optical Fiber Cable - For Indoor Use:

1. Tight buffered, optical fiber cable: to be developed as per design requirements
2. Standards: Comply with:

    1) EN 60794-2
    2) EN 60794-2-11
    3) EN 60794-2-21

B. Optical Fiber Cable - For Indoor/Outdoor Use:

1. Application to be developed as per design requirements
2. Standards: Comply with:

    1) EN 60794-2
    2) EN 60794-2-11
    3) EN 60794-2-21

C. Optical Fiber Cable - For Outdoor Use (Outside Plant):

1. Application to be developed
2. Standards: Comply with:

    1) EN 60794-3
    2) EN 60794-3-12
    3) EN 60794-3-21

D. Optical Fiber Cable - Sheath

E. Number of Fiber Strands / Cores: to be developed as per design requirements

300.060 SINGLE-MODE OPTICAL FIBER CABLE - CATEGORY OS2

A. Application: to be developed

B. Specifications of the Cabled Optical Fiber: to be developed as per design requirements

C. To be developed

300.070 LASER-OPTIMIZED MULTI-MODE OPTICAL FIBER CABLE - CATEGORY OM5

A. Application: to be developed

B. Specifications of the Cabled Optical Fiber: to be developed as per design requirements

300.080 OPTICAL FIBER CABLE HARDWARE

A. Optical Fiber Patch Bays

1. To be developed

B. Patch Cords

1. To be developed

C. Cable Connecting Hardware:

1. Comply with EN 50173-1, Clause 8 for “Connecting Hardware Requirements”.

2. To be developed

300.090 CONSOLIDATION POINT (CP)

A. Description: Consolidation points shall comply with requirements for cable connecting hardware.

1. The CP shall comply with EN 50173-2: to be developed

300.100 TELECOMMUNICATIONS OUTLETS/CONNECTORS

A. Jacks: 100-ohm, balanced, twisted-pair connectors; four-pair, eight-position RJ45 modular Category 6_A components, wired to T568A or T568B pin assignments.

B. Workstation Outlets: to be developed as per design requirements

300.110 GROUNDING

A. Comply with requirements in Division Y, Section "Earthing and Bonding" for grounding conductors and connectors.

B. Comply with EN 50310, EN 50174-2 and EN 50174-3.

300.120 IDENTIFICATION PRODUCTS

A. Comply with requirements in Division W, Section "Identification for Communications Systems (EN)".

B. Comply with EN 50174-1.

300.130 CABLE MANAGEMENT SYSTEM

A. Comply with requirements in Division W, Section “Identification for Communications Systems (EN)" for cable and asset management software.

310.000 QUALITY MANAGEMENT

310.010 PRODUCTS AND WORK BY OTHERS / COORDINATION

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

310.020 CONFIDENTIALITY

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

310.030 QUALITY ASSURANCE

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

310.040 DELIVERY, STORAGE, AND HANDLING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

310.050 WARRANTY

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

310.060 MAINTENANCE AND SUPPORT

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

310.070 SPARE PARTS AND EXTRA MATERIAL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

320.000 SUBMITTALS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Cable Pulling Plan: To be developed

C. Splice Plan: To be developed

D. Cable Testing Plan: To be developed

E. Cable Testing Reports: To be developed

330.000 EXECUTION

330.010 ENTRANCE FACILITIES

A. Coordinate horizontal cabling with the protectors and demarcation point provided by the telecommunications Service Provider.

330.020 WIRING METHODS AND PATHWAYS

A. To be developed

330.030 INSTALLATION OF CABLES

A. General Requirements for Balanced Twisted Pair Horizontal Cabling:

1. Comply with EN 50174-1, EN 50174-2 and EN 50174-3.
2. To be developed

B. General Requirements for Fiber Optic Horizontal Cabling:

1. Comply with EN 50174-1, EN 50174-2 and EN 50174-3.
2. To be developed

C. Open-Cable Installation:

1. To be developed

D. Installation of Cable Routed Exposed under Raised Floors:

1. To be developed

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Refer to Division W, Section “Common Clauses for IT & Security Systems”.
2. Comply with EN 50174-2 for separating metallic communication cable from potential EMI sources, including electrical power lines and equipment.

330.040 FIRESTOPPING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. To be developed

C. Comply with EN 50174-1.

330.050 GROUNDING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Install grounding according to EN 50310, EN 50174-2 and EN 50174-3.

330.060 IDENTIFICATION

A. Comply with requirements for identification specified in Division W, Section "Identification for Communications Systems (EN)."

B. Identify system components, wiring, and cabling complying with EN 50174-1.

330.070 CABLE MANAGEMENT SYSTEM

A. Comply with requirements in Division W, Section "Identification for Communications Systems (EN)" for cable and asset management software.

330.080 FIELD QUALITY CONTROL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

B. Tests and Inspections: To be developed

330.090 DEMONSTRATION AND TRAINING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

W73 – ELECTRONIC VISUAL INFORMATION DISPLAY SYSTEM

1.1 RELATED DOCUMENTS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems” for requirements.

1.2 SUMMARY

A. This section includes the technical specifications for Electronic Visual Information Display System (EVIDS) at for Project.

1.3 REFERENCES

A. Refer to Division W, Section “Common Clauses for IT & Security Systems” for requirements.

1.4 SYSTEM DESCRIPTION

A. The term EVIDS is also known as Flight / Baggage Information Display Systems (FIDS/BIDS) or Multi-User Flight and Baggage Information Display System (MUFIDS) in the industry. For the purpose of this section definition and the associated drawings the term EVIDS will be used to define the system known as MUFIDS or FIDS/BIDS and includes the following related subsystems and processes:

1. Flight Information Display System (FIDS)
2. Baggage Information Display System (BIDS)
3. Gate Information Display System (GIDS)
4. Counter Information Display System (CIDS)
5. Information Display System (IDS)

B. The EVIDS definition includes software and hardware components such as flat-panel display screens, LED dynamic signage, personal computers workstations, application servers, databases, gateways and interfaces to flight record resources from airlines and other third party systems as required to populate daily and season flight schedules in the EVIDS and AODB databases.

C. To Be Developed

1.5 SCOPE OF WORK

A. Refer to Division W, Section “Common Clauses for IT & Security Systems” for requirements.

B. The Contractor shall provide, based on these specifications all equipment, software, licenses, interfaces, material, labor and services required to construct and install the EVIDS .

C. To Be Developed

1.6 SUBMITTALS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems” for requirements.

1.7 QUALITY ASSURANCE

A. Refer to Division W, Section “Common Clauses for IT & Security Systems” for requirements.

1.8 WARRANTY

A. Refer to Division W, Section “Common Clauses for IT & Security Systems” for requirements.

1.9 PRODUCTS

A. Refer to Section “Common Clauses For IT And Security Systems” in addition to the following requirements.

1.10 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers shall meet all specifications requirements and shall be approved by the Engineer.

1.11 SOFTWARE

A. System software shall be furnished, installed and configured as required to meet operational and performance requirements found within this section.

B. All supplied software running on servers or clients shall synchronize to a Network Time Protocol (NTP) source. The Contractor shall coordinate with other trades such as the LAN provider to develop the exact IP address of the NTP source.

1.12 SYSTEM ARCHITECTURE

A. The system shall utilize a multi-tier architecture. End devices shall be clients to the applications servers. Application servers in turn shall communicate with the database servers. All information shall be communicated between the server(s) and clients using the Airport Local Area Network using a dedicated VLAN.

B. Network communications shall utilize TCP/IP network communications protocol. The Contractor shall identify the network bandwidth required to support the EVIDS.

1.13 PERFORMANCE REQUIREMENTS

A. General: The System Design is based upon IATA and Airport Industry EVIDS systems performance requirements, at a minimum the system shall provide functional real time performance supporting airline operations and passenger information resources.

1.14 NETWORK REQUIREMENTS

A. The system shall utilize the Project Operational Network to provide services to all devices and workstations. The primary and backup servers for the system shall be located in two different main communication rooms and shall be connected to the LAN switches via 1000-BaseT Ethernet. Clients shall be connected to the LAN via 10/100/1000 Mbps Ethernet (auto-negotiating). The clients shall communicate with the system applications utilizing the TCP/IP network protocol.

B. All systems shall be capable of being SNMP managed, and monitored by the centralized remote management system. It is understood that the internal proprietary code of the Contractor may be monitored by a specialized program and not by SNMP. However, this must be coordinated with the requirements of the Network and approved by the Airport Project Representative.

C. The EVIDS System provider is required to coordinate with the network provider and participate in network definition and commissioning as required to define IP, VLAN, NTP and DNS needed for operation of displays, servers, tugman keypads and workstations on the airport network.

1.15 GENERAL HARDWARE REQUIREMENTS

A. Server Requirements:

1. Refer to Division W, Section “Computers and Related Peripherals” for minimum requirements.

B. LCD Flat Panel Integrated Controllers

C. EVIDS Workstation (EW)

1. Refer to Division W, Section “Computers and Related Peripherals” for minimum requirements.

D. Peripheral Devices

1. Refer to Division W, Section “Computers and Related Peripherals” for minimum requirements.

E. Tugman-Input Devices

F. To Be Developed

1.16 LCD FLAT-PANEL DISPLAY SCREENS

A. To Be Developed

1.17 LED DYNAMIC SIGNAGE DISPLAYS

A. To Be Developed

1.18 DELIVERY, STORAGE, AND HANDLING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems” for requirements.

1.19 INSTALLATION

A. Refer to Division W, Section “Common Clauses for IT & Security Systems” for requirements.

B. To Be Developed

1.20 EXAMINATION AND FIELD QUALITY CONTROL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems” for requirements.

B. To Be Developed

1.21 TESTING AND COMMISSIONING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems” for requirements.

B. To Be Developed

1.22 TRAINING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems” for requirements.

1.23 CLOSEOUT SUBMITTALS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems” for requirements.

B. To Be Developed

1.24 COMPLETION AND SYSTEM ACCEPTANCE

A. Refer to Division W, Section “Common Clauses for IT & Security Systems” for requirements.

W74 – COMMON USE SYSTEMS

1.1 RELATED DOCUMENTS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”for requirements.

1.2 SUMMARY

A. This section contains the technical specifications for Common Use Systems (CUS) for the Project.

B. The term CUS refers to Common Use Terminal Equipment (CUTE), Self Boarding Gates (SBG), Document Check E-gate (DCE) and Common Use Self-Service (CUSS) kiosks for purposes of passenger processing services.

1.3 REFERENCES

A. Refer to Division W, Section “Common Clauses for IT & Security Systems” for requirements

1.4 SYSTEM DESCRIPTION

A. The term Common Use Systems is also known as Passenger Processing Systems in the industry. For the purpose of this section definition the term CUS will be used to define the system known as Passenger Processing Systems and includes the following related subsystems and processes:

1. Common Use Terminal Equipment (CUTE)
2. Common Use Self Service equipment (CUSS) –.
3. Self Boarding Gates (SBG) –
4. Document Check E-Gate (DCE) –

B. The CUS definition includes software and hardware components such as computer workstations with peripheral devices, kiosks, and boarding pass readers, gateways and interfaces to flight record resources from airlines and other third-party systems as required to provide passenger check-in by agents and self-check-in by passengers.

C. For the expansion scope, the CUS system shall be an extension of the existing CUS system in use at the airport and shall make use of the existing CUS core (servers, core software).

D. The CUS system shall be coordinated with the current CUS provider to meet current technical parameters in place at the airport for the equipment and software and their operation.

1.5 SCOPE OF WORK

A. Refer to Division W, Section “Common Clauses for IT & Security Systems” in addition to the following requirements.

B. The Contractor shall provide, based on this specification section all equipment, software, licenses, interfaces, material, labor and services required to construct and install the CUS .

C. The Contractor shall coordinate with the current CUS provider at the airport to integrate the installation, configuration, and testing of the CUS systems provided under this specification with the existing systems.

D. The Contractor shall utilize the existing Airport Operational Database (AODB), Resource Management System (RMS), and all existing interfaces to airline host systems and external passenger and flight information sources currently in operation at the airport.

E. The Contractor shall not assume the adequacy of the existing systems and shall be fully responsible for verifying the capacity, performance, compatibility, and overall suitability of these systems and interfaces to support the proposed requirements.

F. The Contractor shall assess the existing AODB system and confirm that it has sufficient capacity, performance, and capability to accommodate the proposed requirements, with adequate provision for future expansion.

G. The Contractor shall identify and implement any required upgrades, modifications, or enhancements to the existing systems and interfaces to achieve full functionality, compliance, and seamless integration with the proposed works. All such works shall be deemed part of the Contractor's scope.

H. The Contractor shall confirm that all associated software licenses are valid, current, and fully compliant with manufacturer requirements. The Contractor shall further verify that all core and head-end equipment are not end-of-life (EOL) or end-of-support (EOS) and remain fully supported by the original manufacturer.

I. Any deficiencies identified in the existing systems, including hardware, software, licensing, or interfaces, shall be rectified by the Contractor.

J. The Contractor shall be fully responsible for the planning, coordination, and execution of all required migration activities, including those associated with the dismantling and reinstatement of equipment.

K. All migration and related activities shall be carried out in a controlled and phased manner to ensure no disruption to ongoing airport operations and services.The Contractor shall configure the Common Use Systems in accordance with the Employer's requirements for the systems. The Employer shall be responsible for providing the data and information necessary to complete the system programming to the Contractor in a timely manner.

L. The Contractor shall configure the Common Use Systems to support all commercial airlines operating from the terminals covered by this project.

M. The Contractor shall update programming and integrations within the existing World Tracer and Airport Management System (AMS) applications to accommodate operations within the Terminal Works.

1.6 CONFIDENTIALITY

A. Refer to Division W, Section "Common Clauses for IT & Security Systems".

1.7 SUBMITTALS

A. Refer to Division W, Section "Common Clauses for IT & Security Systems".

B. QUALITY ASSURANCE

C. Refer to Division W, Section "Common Clauses for IT & Security Systems".

1.8 WARRANTY

A. Refer to Division W, Section "Common Clauses for IT & Security Systems".

1.9 MAINTENANCE AND SUPPORT DURING WARRANTY PERIOD

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

1.10 SPARE PARTS AND EXTRA MATERIAL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems” in addition to the following requirements.

B. Contractor shall handover manufacturer’s recommended spare parts for all major components in the system for two years fault-free operation.

C. However, a minimum of 2.5% peripherals of each type installed, but not less than one from each type shall be included in the deliverables irrespective of Manufacturer’s recommendation.

D. Handover manufacturer’s test equipment and tools required for normal routine inspection and maintenance and testing of system components as appropriate for equipment supplied.

PART 2 - PRODUCTS

2.1 GENERAL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems” in addition to the following requirements.

2.2 MANUFACTURERS

A. Equipment and software under this specification section shall be provided by the existing CUS provider at the airport, and shall be compatible with the equipment currently in use, with the most current hardware and software upgrades provided.

B. Subject to compliance with requirements, manufacturers shall meet all specifications requirements and shall be approved by the Engineer.

2.3 SOFTWARE

A. System software shall be furnished, installed and configured as required to meet operational and performance requirements found within this section.

B. All supplied software running on servers or clients shall synchronize to a Network Time Protocol (NTP) source. The CONTRACTOR shall coordinate with other trades such as the LAN provider to develop the exact IP address of the NTP source.

2.4 SYSTEM ARCHITECTURE

A. The system shall utilize an architecture based on the existing CUS system. End devices shall be clients of the application servers. All information shall be communicated between the server(s) and clients using the Airport Local Area Network using a dedicated VLAN.

B. Network communications shall utilize TCP/IP network communications protocol. The CONTRACTOR shall identify the network bandwidth required to support the CUS.

2.5 PERFORMANCE REQUIREMENTS

A. General: The System Design is based upon IATA and Airport Industry CUS systems performance requirements. At a minimum, the system shall provide functional real-time performance supporting airline operations and passenger processing.

B. The System Design shall support the IATA Fast Travel Program.

2.6 NETWORK REQUIREMENTS

A. The system shall utilize the existing Network to provide services to all devices and workstations. The primary and backup servers are existing. Clients shall be connected to the LAN via 10/100/1000 Mbps Ethernet (auto-negotiating). The clients shall communicate with the system applications utilizing the TCP/IP network protocol.

B. All systems shall be capable of being SNMP managed, and monitored by the centralized remote management system. It is understood that the internal proprietary code of the CONTRACTOR may be monitored by a specialized program and not by SNMP. However, this must be coordinated with the requirements of the Operational Network and approved by the Airport Project Representative.

C. The CUS System provider is required to coordinate with the network provider and participate in network definition and commissioning as required to define IP, VLAN, NTP, and DNS needed for operation of workstations, kiosks, and other CUS devices on the airport network.

2.7 GENERAL HARDWARE REQUIREMENTS

A. Equipment shall conform to the current standard and generation for agent-facing workstations as provided by the Common Use System supplier. Minimally the workstations shall meet the Type 1 workstation requirements, as noted in Division W, section”Computers and Peripherals”.

B. Equipment shall be suitable for use and operation under the project and environmental conditions present at the project site, and the locations for each device.

C. Equipment shall be coordinated with the millwork/cabinetry and electrical and communication infrastructure required to operate the equipment.

D. Free-standing equipment shall be coordinated with the interior design of the facility.

E. All CUS equipment shall use industry standard stock for tickets and baggage tags.

2.8 CUS Agent-Facing Workstation – Check-In

A. Agent-facing workstations shall include equipment for installation at the check-in counters, airline service desks, and airline lounges.

B. Equipment shall include:

1. Screen, keyboard, mouse, CPU, and software
2. Ticket printer, using standard stock
3. Bag tag printer, using standard stock
4. Passport reader
5. Magnetic stripe and Smart Card credit/debit card reader, PCI compliant

2.9 CUS Agent-Facing Workstation - Gates

A. Agent facing stations shall include equipment for installation at the gate counters.

B. Equipment shall include:

1. Screen, keyboard, mouse, CPU, and software

2. Ticket printer, using standard stock

3. Bag tag printer, using standard stock (a single item per gate area only)

4. Passport reader

5. Magnetic stripe and Smart Card credit/debit card reader, PCI compliant (a single item per gate area only)

6. Document printer configurable to serve two or more agent facing positions

7. Boarding pass reader

2.10 Self Boarding Gate

A. Install Automated Boarding Gates at the designated locations at the boarding gates.

B. SBGs shall be integrated with the CUTE equipment at the gates, and with the core Common Use Systems.

C. The SBG shall be secure:

1. To prevent that more than one passenger can pass through at a time.

2. To signal when a passenger does not pass through the SSBG after acceptance by the system and shall be automatically be marked as de-boarded.

D. The SBG shall produce GO/NO GO reply in the form of audial and screen alert to the operator and opening of the gate in case of a GO. In case of a GO the screen alert shall show an international symbol (e.g. arrow) that lit green and in case of a NO GO the screen alert shall lit red accompanied by an international symbol (e.g. cross).

E. SBG shall be equipped with a red light on the back of the gate that shall light in case of a failed attempt in order to alert the passenger handling staff.

F. Equipment shall include:

1. Barcode reader capable of reading paper tickets and mobile devices.

2. Display Device
   a. Provides basic text display capabilities such as that found on a gate reader.
   b. Display at least 2 lines of 16-character text using a 10-point font.
   c. Display text based on the full range of Unicode character set.
   d. Display text from left-to-right or right-to-left based on application controls.

3. Automated, mechanical entry barrier

4. Fingerprint Scanner

2.11 Document Check E-Gate

A. Install Automated Boarding Pass Readers at the designated locations.

B. DCEs shall be integrated with the core Common Use Systems to validate the boarding pass information against the scheduled flight operations at the airport

C. The DCE shall be secure To prevent that more than one passenger can pass through at a time.

D. The DCE shall produce GO/NO GO reply in the form of audible and visual alert to the operator and opening of the DCE gate in case of a GO. In case of a GO the screen alert shall show an international symbol (e.g. arrow) that lit green and in case of a NO GO the screen alert shall lit red accompanied by an international symbol (e.g. cross).

E. DCE shall be equipped with a red light on the back of the gate that shall light in case of a failed attempt in order to alert the passenger handling staff.

F. Equipment shall include:

1. Barcode reader capable of reading paper tickets and mobile devices.

2. Display Device
   a. Provides basic text display capabilities such as that found on a gate reader.
   b. Display at least 2 lines of 16-character text using a 10-point font.
   c. Display text based on the full range of Unicode character set.
   d. Display text from left-to-right or right-to-left based on application controls.

3. Automated, mechanical entry barrier

4. Fingerprint Scanner

2.12 Common Use Self Service Equipment

A. Equipment shall include:

1. Digital color touchscreen display

2. Passport reader

3. 1D/2D barcode scanner

4. Magnetic stripe and Smart Card credit/debit card reader, PCI compliant

5. Ticket printer, using standard stock

6. Baggage tag printer, using standard stock

7. Fingerprint Scanner

B. One or more of the kiosks shall be suitable for Universal Access by persons with disabilities. The quantity provided shall be in accordance with applicable requirements and services for Universal Access as per local codes. Quantities to be determined based on architectural, operational, and regulatory requirements.

2.13 Self bag drop, internet code dispenser kisok and information ask me kiosk shall be provided as per the client specification requirement.

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems”.

3.2 SYSTEM ORIGIN AND USE

A. Refer to Division W, Section “Common Clauses for IT & Security Systems” for requirements.

3.3 INSTALLATION

A. Refer to Division W, Section “Common Clauses for IT & Security Systems” in addition to the following requirements.

B. Equipment installation shall be coordinated with the architectural millwork and cabinetry, to ensure proper fit and installation.

C. Equipment shall be coordinated with electrical power and communications circuits necessary to support the equipment.

D. Free-standing equipment, such as CUSS kiosks, SBGs, and DCEs, shall be fixed to the floor or structure with a minimum of four attachment points, and in accordance with KSA requirements for seismic attachments. The attachment shall be suitable to prevent the equipment from being moved or tipped due to inadvertent, intentional or natural forces.

3.4 EXAMINATION AND FIELD QUALITY CONTROL

A. Refer to Division W, Section “Common Clauses for IT & Security Systems” in addition to the following requirements.

B. The works shall be performed by skilled technicians under the direction of experienced engineers, all of whom shall be properly factory trained and qualified for this work.

C. Upon installation of network components, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance to verify that the clocks associated with it are in proper working condition. Remove temporary connections when tests have been satisfactorily completed.

3.5 TESTING AND COMMISSIONING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems” in addition to the following requirements.

B. Testing and commissioning shall demonstrate the following:

1. Connectivity of the screens through the Network to the existing Common Use Systems core.

2. Proper operation of the different workstations, printers, devices, and kiosks, including presenting the correct information and allowing the user to perform the required tasks, in the format and manner required, and in accordance with the expectations of the Employer.

3. Demonstrated operation shall verify the CUS equipment provided under this project conforms to the standard and functions used at the airport with the existing CUS elements, core, and equipment.

3.6 TRAINING

A. Refer to Division W, Section “Common Clauses for IT & Security Systems” for requirements.

3.7 CLOSEOUT SUBMITTALS

A. Refer to Division W, Section “Common Clauses for IT & Security Systems” for requirements.

3.8 COMPLETION AND SYSTEM ACCEPTANCE

A. Refer to Division W, Section “Common Clauses for IT & Security Systems” for requirements.

W75 – AUDIO FREQUENCY INDUCTION LOOP

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions apply to this Section.

1.2 SUMMARY

A. The section includes general design requirements, administration topics and installation for Audio-frequency induction loop systems.

B. Section includes:
1. Audio source - typically a microphone or other audio input.
2. Loop amplifier
3. Induction loop.
4. Receiver(s) - any hearing aid with a 'T' or 'MT' switch or a specially designed loop listening device.

C. Related Sections:
1. To be developed

1.3 REFERENCE STANDARDS

A. Compliance with Local Requirements: Comply with applicable building code, local ordinances and regulations, and requirements of authorities having jurisdiction.

B. Codes and Standards: All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. Equipment and system shall comply with the following Standard:

a. UL 813 - Commercial Audio Equipment or

b. IEC 60268 – Sound System Equipment,

c. BS 6259 - Code of practice for the design, planning, installation, testing and maintenance of sound systems.

d. BS 7594 - Code of practice for audio-frequency induction-loop systems (AFILS).

e. EN60118-4 - Magnetic field strength in audio frequency induction loop systems for hearing aid purposes.

f. BS 8300 - Design of buildings and their approaches to meet the needs of disabled people.

g. IEC TR 63079 (also referred to as BS 7594)

h. BS 62489-1 – Electroacoustics - Audio-Frequency Induction Loop Systems for Assisted Hearing Part 1: Methods of Measuring and Specifying the Performance of System Components.

2. Comply with the latest issue of:

a. NFPA 72, "National Fire Alarm Code".

C. All electrical works shall comply with the local Electricity Regulations.

D. Local regulations and standards, where enforced and relevant, are to have precedence over the Standards.

1.4 DEFINITIONS AND ABBREVIATIONS

A. Refer to Division W " COMMON CLAUSES FOR IT and SECURITY SYSTEMS", in addition to the below:

1. AFILS: Audio-Frequency Induction Loop System.

2. HLS: Hearing Loop Systems.

3. AGC: Automatic Gain Control.

1.5 SCOPE OF WORK

A. Refer to Division W " COMMON CLAUSES FOR IT and SECURITY SYSTEMS".

B. AFILS Equipment shall include all wiring, control cabling, conduit, boxes, connectors and accessories and ancillary work, whether described in the Specification or not, required for a complete and fully operational system.

C. AFILS Equipment shall interface with the Elevator Intercom System.

1.6 PRODUCTS AND WORK BY OTHERS

A. The Employer may separately purchase and/or provide certain equipment and miscellaneous items that will be installed during the course of the installation process. Such items may not be indicated in the documents. Contractor shall coordinate with the Employer and his Suppliers when considering:

1. Structured communications system cabling, termination, identification and testing.
2. Provision and installation of computer hardware, racks/cabinets and related networking software and equipment.
3. Active communication and data processing equipment.
4. Fiber optic cabling infrastructure.
5. Communications grounding busbars and grounding wires connecting to the main building earth electrode system.
6. Dedicated power panels, ground busbars, circuits, floor boxes and utility outlets.
7. Installation and finishing of plywood backboards.
8. Building mechanical ductwork, cooling/heating system and environmental control sensors.
9. Communications and electrical pathway devices both indoors and outdoors such as underground duct banks, manholes, handholes, cable trays, conduits, conduit sleeves, and penetrations in walls and floors.

B. Accordingly, the Contractor shall:

1. Meet jointly with representatives of the above systems, Contractors, Operators, Engineer and Employer to exchange information and agree on details of project implementation, equipment arrangements and interface, etc.
2. Record agreements reached in meetings and distribute record to participants.
3. Adjust arrangements and locations of equipment in technical rooms to accommodate and optimize arrangement and ensure necessary interface with other systems.
4. Coordinate with the other Contractors whose deliveries are necessary for the correct operation of the Audio Frequency Induction Loop system including but not limited to the Data Network, Public Address system, etc.

1.7 CONFIDENTIALITY

A. Refer to Division W " COMMON CLAUSES FOR IT and SECURITY SYSTEMS".

1.8 SUBMITTALS

A. Refer to Division W " COMMON CLAUSES FOR IT and SECURITY SYSTEMS".

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project

B. Source Limitations: Obtain Audio Frequency Induction Loop system (AFILS) from a single source from a single manufacturer.

C. Electrical Components, Devices, and Accessories: All system components shall be UL and/or CE listed.

D. Manufacturers: Firms regularly engaged in the manufacture of AFILS, whose products have been in satisfactory use in similar service for not less than 5 years.

E. Product, Material, Equipment shall demonstrate compliance with requirements specified in Section 016000 "Product Requirements

1.10 DELIVERY, STORAGE AND HANDLING

A. Refer to Division W " COMMON CLAUSES FOR IT and SECURITY SYSTEMS".

1.11 PROJECT/SITE CONDITIONS

A. Refer to Division W " COMMON CLAUSES FOR IT and SECURITY SYSTEMS".

1.12 WARRANTY

A. Refer to Division W " COMMON CLAUSES FOR IT and SECURITY SYSTEMS". for requirements.

1.13 COMMISSIONING

A. Refer to Division W " COMMON CLAUSES FOR IT and SECURITY SYSTEMS"..

1.14 MAINTENANCE AND SUPPORT DURING WARRANTY PERIOD

A. Refer to Division W " COMMON CLAUSES FOR IT and SECURITY SYSTEMS"..

1.15 SPARE PARTS AND EXTRA MATERIAL

A. Refer to Division W " COMMON CLAUSES FOR IT and SECURITY SYSTEMS"..

B. Contractor shall handover manufacturer's recommended spare parts for all major components in the system for two years fault-free operation.

C. However, a minimum of 2.5% peripherals of each type installed, but not less than one from each type shall be included in the deliverables irrespective of Manufacturer's recommendation.

D. Handover manufacturer's test equipment and tools required for normal routine inspection and maintenance and testing of system components as appropriate for equipment supplied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements.

2.2 FUNCTIONAL DESCRIPTION OF SYSTEM

A. Fixed/permanent type loop systems comprising an audio source/microphone, amplifiers, power supplies, and loop wiring.

B. Audio Frequency Induction Loop System (AFILS) shall meet the requirements set by the international standard for loop systems IEC60118-4 to ensure that the system provides a benefit.

C. Containment, raceways and power supplies required for a portable/desk mounted type AFILS.

D. Hearing loop systems should be specified and designed by an experienced specialist to take account of the effect of building structure and overspill where applicable.

2.3 SYSTEM COMPONENT REQUIREMENTS

A. Type B: Counter / local area loop driver
   1. Where the loop system is to assist a single end user in a defined location such as a retail counter or information point,
   2. Desktop Microphone

B. Type C: Public Elevators loop driver
   1. Where the loop system is to assist passengers within the lift car when using the emergency intercom, each hearing loop driver shall be permanently installed

C. HLS Loops / Wiring:

2.4 Audio inputs

A. Audio inputs should be defined by the use of the space and the requirements of the listeners.

B. The audio provided to the HLS must always provide an improvement in signal to noise ratio over the acoustic sound within the room.

C. The Contractor is required to:
1. Provide dedicated microphones and associated audio equipment for the HLS.
2. Co-ordinate with the Elevator contractor to obtain a line level feed from the Elevator Intercom system.
3. Provide suitable input plates for connection into the HLS.

D. Where microphones are being provided for the HLS they must be as close as possible to the talking position. Directional types are often most effective.

E. A single boundary microphone mounted on the ceiling is unlikely to provide sufficient rejection of background acoustic noise in most rooms and should not be used unless it can be demonstrated that the system delivers tangible benefit to those who experience hearing loss.

F. Input levels shall not be adjustable at the signal source or connection point.

2.5 Power Supplies

2.6 NETWORK EQUIPMENT

A. Refer to Division W " COMMON CLAUSES FOR IT and SECURITY SYSTEMS"..

2.7 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. Refer to Division W " COMMON CLAUSES FOR IT and SECURITY SYSTEMS"..

2.8 SIGNAL TRANSMISSION COMPONENTS

A. Refer to Division W " COMMON CLAUSES FOR IT and SECURITY SYSTEMS"..

2.9 CONDUITS, TRUNKING, ENCLOSURES, AND FITTINGS

A. Refer to Division W " COMMON CLAUSES FOR IT and SECURITY SYSTEMS"..

PART 3 - EXECUTION

3.1 EXAMINATION

A. The Contractor shall, at the earliest opportunity in the project:

1. Use a loop design tool to show that any cross-talk between adjacent looped areas, and that magnetic spill from any HLS where the signal is defined as 'confidential' will, by design, be less than -40dB with normal signal levels.

2. Provide evidence that the field strength of the proposed systems will meet the requirements of IEC 60118-4, whilst taking account of any metal within the building structure. Where necessary, the effect of metal shall be assessed by site survey and tested using trial loops on relevant construction, carried out by a competent test specialist.

3. Ensure that the drivers' rated current and voltage is capable of driving the designed loop without clipping or distortion of the signal with full power bandwidth up to at least 1.6 kHz as per IEC 62489.

B. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting the performance of AFILS.

C. Examine roughing-in for embedded and built-in anchors to verify actual locations of AFILS connections before AFILS installation.

D. Prepare written report, endorsed by Installer, listing conditions detrimental to the performance of AFILS.

E. Inspect built-in and cast-in anchor installations, before installing AFILS, to verify that anchor installations comply with requirements. Prepare inspection reports.

1. Remove and replace anchors where inspections indicate that they do not comply with requirements. Re-inspect after repairs or replacements are made.
2. Perform additional inspections to determine compliance of replaced or additional anchor installations. Prepare inspection reports.

F. For material whose orientation is critical for its performance as a ballistic barrier, verify installation orientation.

G. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install AFILS system components, in accordance with manufacturer's written instructions, requirements of applicable Standards, and in accordance with recognized industry practices to ensure that the installation(s) complies with requirements and provides the intended function.

B. If the proposed contractor is not experienced with a hearing loop or audio systems to the level required in order to competently install and commission these systems, then some or all of the work should be sub-contracted to a specialist with the necessary experience.

C. The contractor shall:
1. Co-ordinate with other relevant contractors to ensure that all appropriate audio signals are connected to the hearing loop system and transmitted clearly.
2. Wire and connect to all items of equipment in accordance with the manufacturer's recommendations.
3. Ensure complete segregation of the HLS from any other ELV or LV wiring system.
4. All wiring between loops and equipment locations shall be installed in appropriate containment.
5. All wiring, including that inside equipment enclosures or racks, will be of a neat and tidy appearance. Wiring shall be identified at both ends of each cable.
6. Following installation, the resistance of each loop circuit and isolation from electrical ground shall be tested and recorded. The Client shall have the opportunity to witness these tests.

D. All commissioning must be carried out using a true RMS, dedicated hearing loop field strength meter, meeting the requirements of IEC 60118-4, with a valid calibration certificate available.

E. Each complete system must be commissioned in accordance with IEC 60118-4 and a certificate of conformity clearly stating test results and performance against this standard must be issued for each HLS. The Client shall have the opportunity to witness these tests.

3.3 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by a Client's representative.

B. Manufacturer's Field Service:

C. Perform tests and inspections.

D. Tests and Inspections:

E. Prepare test and inspection reports.

F. Maintenance Test and Inspection:

G. Annual Test and Inspection:

3.4 PROTECTION AND CLEANING

A. Repair exposed surfaces to match the original finish.

B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, which guarantee storage of control equipment is without damage or deterioration at the time of Final Acceptance.

3.5 DEMONSTRATION AND TRAINING

A. Refer to Division W " COMMON CLAUSES FOR IT and SECURITY SYSTEMS", in addition to the below requirements.

B. All systems, methods of use and routine maintenance checks must be demonstrated to the end user.

C. Loop receivers shall be provided for operational staff to check and monitor the performance of the HLS system. Any receiver shall have a headphone output, external selectable low-cut filter, and field strength indicators as required by IEC 60118-4.

D. Training shall be provided that enables operational staff to understand the proper use of the HLS and how to ensure that people can make use of the system effectively.

E. Operation and Maintenance manuals shall be provided which include 'as fitted' drawings, data sheets and instruction manuals for all items of hardware and operational instructions for the use and testing of all systems.

W76 - BAGGAGE RECONCILIATION SYSTEM (BRS)

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes performance and design requirements of the Baggage Reconciliation System (BRS) used throughout the airport.

B. The BRS includes the following related subsystems:

1. Baggage Reconciliation Application: A system to verify boarded passengers' information against checked-in luggage information to ensure that no bags are loaded to aircraft without accompanied passenger.
2. Mobile Terminals: Wireless Scanners to scan and identify bags and tug carts.
3. Interfaces to Departure Control Systems (DCS) and Master System Integration (MSI): to obtain Baggage Source Messages and other flight related information

1.2 EXTRA MATERIAL

A. Provide priced list of manufacturer's test equipment and tools required for normal routine inspection and maintenance and testing of system components as appropriate for equipment supplied.

PART 2 - PRODUCTS

2.1 DESIGN REQUIREMENTS

A. System Architecture shall be based on a "Client-Server" configuration.

B. System and applications software shall be controlled and configured by working parameters stored in tables and easy to change without programming.

C. The system shall be easy to deploy throughout the whole airport.

D. The system shall be able to accept multiple devices of different types, technologies and manufacturers.

E. The Contractor shall ensure that the system does not cause any interference to other systems, including radar, radio and navigation systems.

F. Operational Constraints: The system will run 24 hours per day, all the days of the year.

2.2 BRS APPLICATION KEY REQUIREMENTS

A. The BRS shall receive passenger-boarded data from the Boarding Control System and update passenger/baggage status in the BRS database accordingly.

B. The BRS shall provide easy retrieval of information on each bag to include:

1. Flight number.
2. Departing gate number.
3. Flight destination.
4. Outbound flight number.
5. Outbound destination.
6. Passenger name.
7. Passenger class.
8. Passenger status (e.g., standby).
9. Container ID.
10. Container load position.
11. Status of flight.
12. Bag Sequence Number.

C. The system shall include dot matrix printers to facilitate printing of triplicates of manifests and baggage loading instructions.

D. Wireless scanners (Hand-held Scanner)

E. Label Printer

2.3 SYSTEM FUNCTIONAL REQUIREMENTS

A. Graphical User Interface (GUI):

1. All system applications shall have a graphical user interface to facilitate human interaction with the application and easy management of data.Retain paragraph and associated sub-paragraph below if applicable to the Project

PART 3 - EXECUTION

3.1 INSTALLATION
3.2 FIELD QUALITY CONTROL
3.3 DEMONSTRATION AND TRAINING

X10A - ELECTRIC TRACTION LIFTS

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. This Section includes the following:

1. Electric traction passenger lifts.
2. Electric traction service lifts.

110.000 DESIGN PARAMETERS

110.010 DEFINITIONS AND ABBREVIATIONS

A. The following terms used on Drawings and in the Specification are synonymous and may be used interchangeably:

1. "Elevator" and "Lift".

B. Electric Traction Lifts: Lifts in which cars are hoisted by wire ropes using electrically driven traction sheaves and are defined to include driving machines, cars, hoistway doors, guide rails, guide-rail brackets, roping, buffers, counterweights, signals, control systems, electrical wiring within lift system, and devices for operations, safety, security, required performance at rated speed and capacity, and for complete lift installation.

C. Defective Lift Work: Operation or control system failures, performances below specified ratings, excessive wear, unusual deterioration or aging of materials or finishes, unsafe conditions, the need for excessive maintenance, abnormal noise or vibration, and similar unusual, unexpected, and unsatisfactory conditions.

110.020 REFERENCE STANDARDS

A. Regulatory Requirements: In addition to local governing regulations, comply with the applicable provisions of the following standards, referred to as the "Code":

1. EN 81, "Safety Rules for the Construction and Installation of Lifts ".
2. EN 81-20 and EN 81-50 Standards with all listed normative references, including those issued by ISO, IEC, CEN and CENELEC and any other standard referred to.
3. BS ISO 8100-30 "Lifts for the transport of persons and goods, Class I, II, III and VI lifts installation".
4. BS 5655 "Lifts and service Lifts".
5. EN 81- Part 72 "Firefighters lifts".
6. EN 81- Part 73 "Behaviour of lifts in the event of fire".
7. EN 81- Part 70 "Accessibility to lifts for persons including persons with disability".
8. EN81- Part 58 "Landing doors fire resistance test".
9. EN81- Part 28 "Remote alarm on passenger and goods passenger lifts".
10. BS 8486: Part 3, “Examination and Test of new Lifts before putting into service. Specification for means of determining compliance with BS EN 81 - Passenger and goods passenger lifts conforming to BS EN 81-20”.
11. Power supply and electrical installations shall conform to the local power authority practices.
12. All electric power installations shall comply with relevant IEC standards and BS 7671 "IET Wiring Regulations" where not in contradiction with local authority.
13. Electromagnetic compatibility (EMC): EN 12015 (emission) and EN 12016 (immunity).
14. Nominal characteristics of all equipment forming part of the electrical works shall be specified to conform to the relevant International Electro-technical Commission (IEC) Standards and the International Standards Organization (ISO).
15. CIBSE Guide D “Transportation Systems in Buildings”.
16. BS 7255 "Code of Practice for Safe Working on Lifts".

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17. The local code of practice for electric lifts in buildings.

120.000 SYSTEM DESCRIPTION

120.010 MACHINE AND DRIVE (MACHINE ROOMLESS LIFT TYPE)

A. Machine Room-Less Lifts: All machine-room-less lifts shall be powered by gearless machines with permanent magnet synchronous motors mounted in the overhead inside the lift shaft. Neither machines nor controllers are allowed to be placed in the pit. Provide variable voltage variable frequency drives built into the control panel and located inside the shaft next to the machine. A machine access panel shall be built in either the landing door frame or the adjacent wall at the last served floor to facilitate maintenance, and emergency applications.

B. Gearless Machine-Drive: To have traction sheave and brake.

C. Gearless Machine-Motor: Enclosed, ventilated type.

D. Gearless Machine-Bearings: Sleeve or anti-friction type, properly lubricated, of ample capacity to sustain heavy loads supported by machine, and rigidly mounted in proper alignment. Sleeve bearings shall have automatic lubrication. Sound isolation pads shall be provided to reduce vibration and noise transmission to building structure.

E. Gearless Machine-Brake: Dual independent brakes shall be provided and shall be noiseless, spring applied, magnetically released, self-cooling and capable of holding car securely under maximum speed and load conditions. Brake shall be designed for automatic and instantaneous application immediately after power is interrupted on motor. Brake springs shall work in compression.

F. Gearless Machine-Manual Brake Release: Provide means for manual release of brake, to allow manual winding of unit in emergencies. Necessary levers and handles shall be handed to the Employer, with instructions for use. Brake emergency release shall be self-resetting.

G. Motors shall be rated at a minimum of 180 starts per hour.

H. Gearless Machine motor insulation shall be Class F and have IP 21 degree of protection to IEC 60529, Motor noise shall not exceed 60 dB (A) at 1 meter outside the machine room.

I. Motor Acceleration and Jerk: Motors shall produce a smooth constant acceleration / deceleration and not less than 0.8 m/sec2 with an initial ramp between 0.5 and 0.75 second. Sustained jerk rate shall not exceed 1.5 m/sec3.

J. Traction and Deflection Sheaves: Traction sheave shall be fine grained cast iron of suitable hardness, accurately grooved for number and size of hoisting ropes, and shall give constant traction and long rope life. Bearings for sheaves shall be approved type. Diameter of sheave shall be not less than forty times overall diameter of ropes. Deflection and secondary sheaves shall be of same material and grooved similarly to traction sheave and shall be protected by guards extending below machine level, when required.

K. Stopping accuracy: Maximum tolerance ± 5 mm. Accuracy shall be maintained regardless of change of load or rope stretch.

L. Power Regenerative Converter: a means shall be provided for removing regenerated power from the drive system. This power shall be dissipated in resistors or return to the three-phase A.C. power supply system. Failure of the system to remove the regenerated power shall cause the drive output to be removed from the hoist motor. The energy generated during the inverter braking for regeneration shall be performed through the following method:

   1. For lifts where the result of multiplying load and speed is less than 3500 kg.m/s, combined brake unit and discharging resistors shall be used according to the manufacturer's recommendations.
   2. For lifts where the result of multiplying load and speed is more than 3500 kg.m/s, power converter shall be used.

M. Natural ventilation opening shall be provided at the top or side of the shaft with all required protection against dust and drain, opening size shall be minimum 300 mm x 300 mm subject to supplier final recommendation and engineer's approval. In case the lift is located at atrium; natural ventilation opening shall be at the top of the shaft.

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N. Motor Rating: It is the contractor's responsibility, and in accordance with the Standards requirements, to provide and install, the motor drive properly sized and suitable to lift the required rated passengers' capacity in addition to the specified car dimensions.

O. Elevator Capacity: It is the contractor's responsibility, and in accordance with the specified car dimensions to provide the related capacity in accordance with the requirements of standards. The capacity of the elevators mentioned in the schedules is nominal and reflects the required transport capacity.

120.020 CAR

A. Construction: Structural steel frame members suitably braced and fastened together, and clad internally and externally with sheet metal at least 1.5 mm thick, which shall not drum during normal operation. Materials shall be fire resistant.

B. Reinforce roof to sustain 150-kg load on any 0.2 m2, and 50 kg at any point. Provide trap door at least 500 x 600 mm, opening outward and capable of being opened from both sides. Opening of trap shall activate electrical interlock preventing operation of lift.

C. Platform: Fill frame with timber sub-floor and provide specified top floor finish. Protect underside of platform with sheet steel covering, at least 1.5 mm thick. Sill shall be anti-slip, with provision for car doors.

D. Load Weighing Device: Build into floor.

E. Isolating Cushion: Rubber pads supported on auxiliary steel frame fastened to car frame shall form isolating cushion between car and car frame.

F. Balustrade and Kick-Plates shall be fitted to car roof in all lifts as per code requirements.

G. Bumper Rails and Kick Plates: shall be fitted inside the car of the freight lifts. They are provided for service lifts if requested in lift data sheets.

H. Bumper Rails and kick-plates fitted to car shall not be less than 75 mm and 150 mm wide respectively.

I. Ventilation and LED Lighting: each car shall have necessary lighting and adequately rated, silent running, properly padded and rigidly fixed exhaust fan of approved type and manufacturer. Fan and lights shall be switched on automatically when car is called or when landing doors are opened, remain switched on whilst car is in operation, and switched off by time delay 30 - 60 seconds after car has stopped. Lighting level shall be minimum 100 lux. Fan shall be provided to bring air into car through the ventilation slots near the wall base and to exhaust through the ceiling. Fan shall be 2-speed to provide at least 1 air change a minute at low speed and 1.5 air change a minute at high speed. A screen grill over the fan shall be provided for mechanical protection of fan. Lighting type and arrangement is subject to Engineer's approval. Battery shall be provided to operate fan, two of the lighting fixtures (subject to complying with EN 81-20 for cabin emergency lighting level), intercom and alarm bell for at least one hour. Battery shall be sealed nickel cadmium or lithium type.

J. For lighting fixtures specifications, refer to Division V section "Interior Lighting".

K. Natural ventilation shall be provided for each car irrespective of provision of forced ventilation.

L. Indicators and control stations shall be provided in each car according to sub-section hereafter.

M. Padded Covers: Provide one set with each type of service lift, to protect car finishes from damage at times lift is used to carry freight. Provide hooks for hanging padded covers.

N. Noise Level Inside the Car shall not exceed the following values:

1. 50 dBA at full speed in both directions with fan off,
2. 55 dBA at full speed in both directions with fan on at high speed.

O. Noise Level outside Car shall not exceed 55 dBA when measured at one meter in front of car entrance during a full door open and close cycle and a reversal cycle, in addition to a lift traveling at full speed inside the shaft.

P. Car Horizontal Acceleration: Lateral quaking, peak to peak, shall not exceed 15 milli-g.

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Q. Car Inspection Station shall be provided on top of the car and at the lift pit according to EN81-20/50 to include the following:

1. Two-position (auto/inspection) switch.
2. Run button, to be pressed in conjunction with up and down direction buttons. This to prevent accidental running under inspection.
3. Stop switch.
4. Duplex electrical socket standard type.
5. Work light to be either plugged into the electrical socket or directly wired into the top of car station. If directly wired "off/on" switch is required on the top of car station.

When the station is switched to inspection, the lift speed shall not exceed 0.63 m/s and all operating devices in the car shall be inoperative.

R. Notices and Signages: A stainless steel grade 304 load plate shall be provided inside the car indicating the following:

1. Rated load.
2. Name of company, telephone number and emergency instruction.
3. Fire instructions “In case of fire do not use lift”.

S. Car Finish: Refer to lifts schedules and related drawings.

T. Loading Class: Freight and service lifts shall have loading class C3 unless loading class C1 or C2 are specified in lift schedules.

U. CCTV Security Cameras: Install color CCTV security cameras (compatible with the building security contractor’s monitoring system) concealed in the lift dropped ceilings and positioned to view the complete lift cab interiors and the car position indicator. Provide shielded wire pairs or coaxial cables from each CCTV camera run to the lift machine room or to machine location inside shaft for machine-room-less.

120.030 AUXILIARIES

A. Counterweight: Structural steel frame fitted with cast iron sub-weights secured with tie rods or steel sub-weights with locks at the top. Weight shall be equal to total car weight plus 40 to 50% of contract specified capacity. Counterweight shall be screened to a height of 2 m from bottom of pit and fitted with renewable guide shoes at top and bottom. Blocking shall be provided between counterweight and buffer strike plate for at least 250 mm per 60 rope length.

B. Guide Shoes: shall be rolling type for speeds exceeding 2 m/sec and sliding type for speeds 2 m/sec and below. Guide shoes shall be adjustable, renewable, and fastened to top and bottom of car and counterweight frames.

C. Roller Guide Shoes: roller guide shoes shall be adjustable mounting base type, rigidly bolted to the top and bottom of each side of car and counterweight frame. Roller guides shall consist of set of sound reducing rubber-covered wheels with precision ball bearings held in contact with the three finished rail surfaces by adjustable stabilizing springs. Roller guides shall be equipped with adjustable stops to control past wise float. The car and counterweight roller guides shall rotate at an adequate speed (rpm) to maximize roller guide life and car ride comfort. Statically balance the car and counterweight to maintain uniform pressure on the roller guides.

D. Guide Rails: highest quality steel T-sections with tongue and grove joints for the car and counterweight. Guide rails sections shall relate to machine fish plates. Unless otherwise indicated, use car and counterweights guide rails with a suitable rail sizes to EN 81-20/50 and profiles as per ISO standards rail sections. When rail length exceeds 30 m means shall be provided to absorb rail expansion and structural settlement. Guide rail fixings shall be heavy steel brackets using metal C-inserts in concrete walls. Guide rail and fixings shall withstand sudden application of safety gear under maximum load.

E. Inserts: coordinate with builder's works to furnish required concrete inserts and similar anchorage devices for the installation of guide rails, machinery, and other components of lift work where installation of devices is indicated as work. Provide necessary shop drawings for the required works.

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F. Suspension Ropes: special acid quality steel or high grade traction steel, single factory production patch with safety factor as specified by EN 81-20/50. Ropes shall be securely attached to car and counterweight and shall have independent means of adjustment. Provide test certificates of compliance with appropriate Code and/or Standard prior to shipment. For travels above 60 m, provide steel cord governor ropes to limit movement of the governor tension wheel due to changing humidity values. An automatic tensioning device shall be provided to equalize the tension of suspension ropes.

G. Roping Arrangement: roping arrangements used are subject to verification by the manufacturer and approval of the Engineer.

H. Compensation Ropes:

1. Provide compensation for the weight of the hoist way ropes and unbalanced portion of the traveling cables whenever the travel exceeds 30 m so that the system balance does not vary by more than 50 kg over the entire range of travel.
2. Compensation Ropes: compensation shall consist of steel wire ropes for speeds 3 m/sec & above and chain with a fire retardant round resilient rubber cover for rated speeds less than 3 m/sec.
3. Compensation ropes shall be attached to the underside of the car and to the counterweight passing under a weighed compensation sheave in the pit. Provide lockdown as described in EN 81-20/50 to the compensation sheave assembly, whenever rope compensation is applied. Provisions shall be made for equalizing tension in the compensating ropes. The guide sheave shall be provided with bearings of anti-friction bearing metal, ball or roller type. The guide sheave shall operate in guides, and the guide structure shall be securely fastened in place. Provide metal guards to prevent ropes jumping off sheave and to prevent foreign objects from falling between ropes and sheave grooves and to protect workmen. Provide upper and lower travel limit switched on the compensation guide sheave. When actuated, power to the drive and brake shall be removed.

I. Buffers: buffers shall be of approved design, oil type for speeds exceeding 1 m/sec and spring or polyurethane type for speeds of 1 m/sec and below unless otherwise indicated. Buffers shall be installed under each car and counterweight. Use reduced stroke buffers with associated terminal slowdown devices where runbys are restrictive. Buffers shall be tested by a qualified testing laboratory and approved as complying with the governing Code.

1. Oil Buffers: provide oil buffers with necessary blocking and horizontal steel braces. Oil buffers shall bring the car and counterweight to rest from governor tripping speed at an average rate of retardation not exceeding gravity. Oil buffers shall be of the spring return type and shall have means of the checking oil supply level and shall provide a limit switch as a backup for the oil level. Oil buffers shall have a marking plate indicating the manufacturer's name, the buffers identification number and the stroke.
2. Spring Type or Polyurethane Buffers shall be in full compliance with the code requirements. Buffers shall be designed and constructed to absorb within the limits of their stroke, the whole kinetic energy of the car carrying its rated load when the speed of impact is the maximum governor tripping speed.

J. Governor Actuated Mechanical Safety Gear: mechanical safety gear shall be mounted on and securely fastened to car frame and actuated by a governor mounted in machine room. Governor shall be directly driven by steel cable. Safety gear and governor shall be in compliance with EN 81-20/50. Governor shall be accurately adjusted and sealed to trip safety gear according to EN 81-20/50 requirements. Operation of governor on over speed is also a switch disconnecting power from motor and brake control circuits, which shall be open before safety gear is applied. Restoration of power shall not be possible until safety gear has been manually re-set. Governor shall be sealed and tagged in accordance with EN 81-20/50.

K. Safety Gear: safety gear shall hold car securely under maximum load and governor tripping speed conditions. Jaws shall engage guide rails through self-aligning shoes with surfaces carefully machined parallel to guide rail face. Pressure of jaws on the two guides shall be equal. Safety gear shall bring car to stop from governor tripping speed. Make provisions to release the car safety. In no event the safety shall be released by downward motion of the car. Raising the car to reset the safety gear shall be allowed. An electrical safety plank switch shall be provided to interrupt the power to the hoist machine when the safety gear is set. Safety Gear shall be type tested in accordance

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with EN 81-20/50 by an approved independent test body. Certified type test report shall be submitted for approval. Install a car safety marking plate of corrosion resistant metal and, in addition to the data required by the governing code, indicate the manufacturer's name and manufacturer's catalogue designation number for the safety gear.

L. Safety Gear Type shall be progressive (gradual) type if the lift rated speed is 1 m/sec or above and progressive (gradual) or instantaneous type if the lift rated speed is below 1 m/sec unless otherwise indicated.

M. Counterweight shall have safety gear for all lifts that have an occupied space below the pit.

N. Governor Ropes: the over speed governor shall be driven by a wire rope designed for that purpose with minimum diameter of 6 mm and shall be easily detachable from the safety gear. The ratio between the pitch diameter of the pulleys for the over speed governor ropes and the nominal rope diameter shall be at least 30. The over speed governor rope shall be tensioned by a tensioning guided pulley. Design the governor rope-tripping device so that no appreciable damage to or deformation of the governor rope shall result from the stopping action of the device in operating the car safety.

O. Lift Pit Stop Switches: Two switches shall be provided at each lift pit as per EN81-20/50 to stop the lift and prevent it from any further movement until placed back to the “Run” position.

P. Pit water drainage system: lift pit bottom shall be smooth pit' bottom with little slop to the drain which shall be provided with automatic water level sensor and connected to the drainage system network.

Q. Pit Access: An access door or pit ladder shall be provided for the access of the lift pit according to EN 81-20/50 requirements.

R. Refuge Space: sufficient refuge space shall be provided at the pit and at the lift headroom. Refuge space shall be clearly demarcated. Signs shall be provided on the car roof and in the pit and shall be readable from the access to the car roof / pit, such signs shall clearly indicate the allowed number of persons and the type of posture considered for the refuge space(s) accommodation. Comply with EN 81-20 requirements.

S. Pit and machine room access doors along with emergency, inspection and trap doors shall be provided in accordance with EN 81-20 requirements and shall satisfy the minimum dimensions indicated in EN 81-20.

T. All civil works required by the standards inside shafts (dividing beams, etc.), inside machine room (beams to support pulleys, etc.) and inside pits (safety screens, pulleys supports, buffer pads, etc.) shall be included in this scope of work.

120.040 DOORS

A. Opening Sizes: Landing and car door openings shall be of the same size.

B. Automatic Sliding Car and Landing Doors: power operated type, open silently, and shall have the following features:

1. Hangers and tracks of two-point suspension ball or roller bearing type; doors guided at bottom by gibes in grooved sill; grooves and tracks cleaned automatically by operation of doors.
2. All landing doors shall be insulated, 2-hours fire rated as per EN 81-58 and EN 1363 standards. Criteria of door performance shall satisfy both integrity (E) and thermal insulation (I) tests. For the low rise residential buildings, 6 floors and less; non-insulated, 2-hours fire rated doors satisfying integrity test (E) can be used.
3. Infrared light-beam (minimum of 35 beams) shall open doors when light-beam is interrupted and to automatically optimize time of opening and reclosing through microprocessor based controller. Alternative protection devices may be used for service lifts, details shall be provided for engineer’s review and approval.
4. Include extended door hold open button in the main car operating panel for all service and freight lifts to extend the door open time (10-20 sec, time to be adjustable through proper programing) to facilitate cart transfer. Registration or re-registration of a car call shall cancel the hold open time.

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5. Doors shall open automatically and simultaneously when car stops at required floor, shall remain open for a reasonable, adjustable period, and automatically and simultaneously close, as set in lift control sequence.
6. 'Door open' push button on car control panel shall reverse door closing operation, but shall not open an interlocked door.
7. Door contact to prevent operation of the car unless the car door is in the closed position. The door contacts are not be readily accessible from the inside of the car.
8. Nudging facility so that if the doors are held open for a predetermined time (15 to 20 seconds) by interrupting the light beams or by holding the door, or by pressing the door open button, a buzzer shall sound and the doors shall start to close at reduced rate of speed. Doors shall continue to close unless the door force limits are not exceeded, which shall cause doors to reopen or stop. Process shall continue until obstruction is removed from entrance.
9. Adjustable door dwelling time, the time interval that lift doors stand open after a stop shall be independently adjustable for car call stops and hall call stops. A separate door time shall be adjustable for lobby door hall calls.
10. Advance door opening, the car and hall doors shall begin to open while the car is preparing to stop at a landing to answer a call. The distance from a landing at which the doors begin to open shall comply with applicable codes.

C. Electric Door Operator driven by a heavy duty electric motor, minimum IP 23 for firefighting lifts and IP 21 for other lifts, shall open and close car and landing doors simultaneously. Door operation shall be automatically controlled by lift control system. Doors shall be mechanically secured and electrically interlocked when closed. Electric door operator shall have the following features:

1. Variable voltage variable frequency (VVVF) electric motor driving unit, mounted on car top (vibration isolated from car body) to operate the car and hoist way doors simultaneously, with necessary gears, levers, door arms, belts and ropes to achieve smooth operation of doors in both directions and an opening speed higher than closing speed.
2. Digital closed-loop system to monitor and control the door speed.
3. Torque limiting clutch to prevent harm to persons caught by closing door, but to overcome small obstructions in bottom guide track.
4. Manual opening of doors shall be possible in the event of power failure, if car is at landing, landing door shall open with car door; mechanism shall reset automatically.
5. With installations, in which doors commence opening while car is leveling to landing, mechanical and electrical devices shall ensure no dangerous situation can occur during this period.

D. Emergency Doors: for express runs exceeding 11m, provide emergency landing door every 11m complying with EN81-20/50 requirements. Emergency landing doors shall be of same type, size and finish of other landing doors of the same lift group (except where otherwise indicated on the drawings), 2 hours fire rated and shall be provided by the lift supplier.

E. Door Frames and Sills: door support units and sill supports fitted at landing entrance shall be self-contained and provided by lift contractor, comprising sill, two angle uprights and head. Non-slip sill shall be fitted at each landing and car entrance. Sills shall be made of extruded hard aluminum with rubbish disposal halls.

120.050 VARIABLE VOLTAGE VARIABLE FREQUENCY (VVVF) DRIVE CONTROLLER

A. Motor Drive: unless otherwise indicated or specified, use 3-phase, solid state, variable-voltage variable-frequency (VVVF) power drive with regulated closed loop speed monitoring control system. Drive shall utilize IGBT power semi-conductors having means for heat dissipation and overheat protection (include thermal overload).

B. Continuous Operation: drive shall be designed for continuous operation at rated speed and rated load, and for 10 minutes at rated speed and 110 percent of rated load, without overheating. Ensure that, in such operating conditions, normal power sources are not adversely affected and emergency generator circuits (and loads connected to the emergency power bus) are not adversely affected during standby power operation. Protect each power feed line against surge currents. Prevent runaway in the event of closed loop feedback circuit failure.

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C. Electronic Negative Feedback System: shall be used to limit current through IGBT's and motor, incorporating:

1. Pattern-generator giving a velocity input signal modified by car position, with constant peak acceleration and constant change of acceleration.
2. Encoder to provide a velocity feedback signal.
3. Digital transducer to provide a position feedback signal.
4. Current transformer to provide a current feedback signal.

D. Power line noise shall comply with IEC 61000-3-4. Necessary filters shall be provided to limit the feedback current harmonics to standard limits.

E. Overall Drive System Response: arrange system response so that the elapsed time between fault detection and removal of electric power does not exceed 0.1 second. Overall drive efficiency shall be greater than 95 percent. Power factor shall be 0.95 minimum.

F. Power supply equipment shall be designed to operate at ± 10 percent supply voltage and ± 3 percent supply frequency, without damage to any equipment and to operate at ± 5 percent supply voltage and ± 3 percent supply frequency without affecting operational performance quality. Protective devices shall be provided for both over-voltage and under-voltage conditions. Protect against loss of phase, phase reversal or overload. Incoming power supply shall be provided with contactor inside the control panel.

G. Controller: the controller shall be microprocessor-based and provided with the following operating features and performance functions:

1. Digital control, with adjustments that do not vary, drift or age with line voltage changes.
2. Linearity between required torque and torque output.
3. Precise closed-loop speed, regulated to less than ± 1% by frequency compensation.
4. S-curve 'soft' start/stop, with a fast speed response system.
5. Diagnostic record of the history of the lift operating conditions, from the instant of the last fault occurrence back 30 days minimum, and to include the following as a minimum:

    a) Emergency Faults.
    b) Fire service activation.
    c) Inspection mode.
    d) Independent service.
    e) Time out of service.
    f) Car out of service.
    g) Safety edge failure.
    h) Emergency power.

6. Application-specific memory to support logic function programming, to tailor the drive.
7. Quiet motor operation, based on high switching frequencies and low harmonic content.
8. Full function operator interface with alphanumeric display. Include: a menu structure with scrolling to reveal system options and display parameters; and interactive interface to permit display and ready changing of parameter values; constant pressure jog for pre-set speed control; motor rotation direction selector; run/stop commands.
9. Protective features including phase-to-phase and phase-to-neutral short-circuit protection; ground fault protection; electronic motor overload protection; over-torque and under-torque detection; over current, over-voltage ad over-temperature detection; input/output phase loss.
10. Noise filter between hoist way wiring and controller to eliminate interference.

H. Protection: system shall be protected against the following:

1. An error level exceeds the signal by more than 5 percent.
2. Actual acceleration exceeds a pre-set pattern more than 15 percent.
3. Excessive transistor switching time or overheating of solid-state components.
4. Car positions as derived from a digital transducer and an integrated velocity feedback signals differ by more than 12 mm.
5. No voltage or sustained under voltage.
6. Over current in any component.
7. Phase reversal of power supply.

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I. Wiring: install copper wiring runs shall be neatly installed. Wire shall be terminated at studs or terminal strips, with connections to ensure substantial electrical and mechanical integrity. All major components shall be exactly identified as indicated on wiring diagrams by engravings or tags mounted immediately adjacent to the component.

J. Enclosure shall be a sheet metal cabinet totally enclosed, IP 21 with removable hinged doors (key-locked) and with filtered ventilation sufficient to maintain interior temperature at a reasonable level.

K. Auxiliary Emergency Supply: control system shall operate from rectified AC supply, at a suitably selected and approved DC voltage. Negative terminal shall be connected to earth. Battery shall be sealed nickel cadmium or lithium type, capable of operating intercom, car fan, lights and alarm circuits for [**one]** hour, in the event of power failure.

120.060 ELECTRICAL EQUIPMENT

A. Equipment generally shall be in accordance with the requirements of relevant Division V Sections.

B. Provide all wiring for proper operation and control of equipment in accordance with electrical Specifications and applicable Codes. Provide wiring for communications facilities and connection to the various related low current systems and building management system.

C. Power Supply Variations: Equipment shall operate satisfactorily if voltage varies ±10% and/or frequency varies ±3% from nominal.

D. Wires and cables inside machine room shall be silicon rubber or PVC insulated, 600/1000 V grade, flame retardant. MICC and silicon rubber insulated cables shall be used for high ambient temperatures. Conductors shall be copper.

E. Conduits and Wireways: Wiring and cables shall be enclosed in heavy gauge galvanized steel conduits.

F. Earthing: Metal frames of lift installations shall be earthed according to Division Y Section "Earthing And Bonding".

120.070 CONTROL ACCESSORIES

A. General: Provide all necessary car, landing and other control accessories as required by specified control system.

B. Car control panel shall be located in an approved convenient position and shall contain at least the following:

1. A call button for each floor served, illuminated when pressed and switched off when the calls are answered
2. LED car position indicator with up/down illumination arrows to indicate the floor at which the car has stopped or passing.
3. Alarm push button.
4. Audible signal to indicate that car is stopping at the required floor.
5. Car fire emergency key switch (for fire fighter lifts).
6. Independent key operated switch.
7. Door open and door close pushes.
8. Extended time hold button for service and freight lifts.
9. Overweight indication and buzzer.
10. Intercom station.
11. Maintenance and test switches with locked cover.
12. Provision for fire jack telephone (including installation of telephone cables with lift travelling cable to machine room / MRL control panel location. Coordinate with main contractor to obtain jack and cable.
13. Provision of outlet for card reader, as required for special floor access. Coordinate with main Contractor for requirements.

C. Car locked service cabinet shall be flush mounted, located below the car call buttons and contain the switches required to operate and maintain the lift, including, but not limited to the following:

1. Key operated priority service switch for isolation purposes.

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2. Duplex socket standard type.
3. Emergency light test button or switch.
4. Fan switch.

D. Additional Car Features: provide two-car control stations in all passenger and service/freight lifts with through type entrance and passenger lifts above 1000 kg capacity. Equip only one with required keyed control switches (if any).

E. Cross Connection Box: trailing control cable shall terminate at a terminal block in the cross connection box on top of the car. The Cross connection box shall contain necessary control pushes for maintenance, lamp with switch and a convenient power socket.

F. Hall Push-Button Station: provide hall push-button station at each landing for each lift or group of lifts, but not less than two stations for each 3 lifts in a group.

G. Hall Push-Button Stations shall comprise up and down pushes and associated illuminated arrows to indicate registered call. Terminal landings shall have one push and one arrow. Illuminated arrow shall switch off when call is answered. Push buttons shall be most up-to-date, mechanical, soft touch.

H. Hall Push-Button Operation: prevent simultaneous up and down call registration by delaying acceptance of the second call registration for 4 seconds (adjustable).

I. Hall Lanterns: For a group of four lifts and more, provide a visual and audible signal at each entrance to indicate which car will stop in response to the hall call. The lanterns with up and down indications at intermediate landings and a single direction indication at each terminal landing shall sound once for the up direction and twice for the down direction to notify passengers which car will answer the hall call.

J. Hall Position Indicator: provide LED type position indicator at each hoistway entrance. Match materials, finishes, and mounting method of hall push-button stations.

K. Emergency Key shall open all landing doors shall be handed to the Employer.

L. Speech Synthesizer: Provide an English speech synthesizer complete with microprocessor vocabulary chips loudspeaker control and all accessories shall be provided unless otherwise specified. It shall be used for broadcasting to car passengers the following Discretionary messages below shall be provided as a minimum:

1. Floor arrival
2. Up/Down direction
3. Lift full
4. Obstructed doors
5. Other announcements if required by Engineer.

M. Fireman switch, installed in a locked cabinet with break glass feature, shall be provided at fire fighter lift bank. Cabinet shall be located at main landing floor, in an approved easily accessible position. Identification and inscription shall be engraved on the face plate. Refer to "Control Systems" Article for description of operation.

120.080 CONTROL SYSTEMS

A. Interlock: No car shall be able to move unless car and corresponding landing doors are fully closed and interlocked. It shall not be possible to open landing door, except that at which car is stopped, and any other door without the use of special tamperproof key.

B. Anti-Nuisance Feature: in the event of car loading or operation is not commensurate with the number of car calls registered, all calls shall be cancelled.

C. Operation From Emergency Supply: In the event of normal power supply failure all lifts shall stop. Upon receiving signal that emergency a.c. power supply is on, control system shall return lifts one at a time, in sequence, directly to main floor giving priority to loaded cars. When lift arrives at main floor, doors shall open and remain open, and lift shall remain stopped. One lift of each bank, unless otherwise shown on the drawings, is then to be operational and shall respond to car and landing calls. If a car cannot be returned after two attempts, it is removed from the system. When all cars have been returned or removed from the system, one car is automatically placed in service. If car selected for service cannot operate within 60 seconds, the system removes car from service and

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places another car in service. Cars can be manually put in service on standby power, either for return operation or for regular operation, by switches located at fire command station. Manual operation causes automatic operation to cease. After restoration of normal power supply all lifts shall resume normal service automatically

D. Operation from Emergency Power Batteries: If the normal power supply fails, lifts shall automatically switch to battery operation as a first step. Each lift shall move in the "light" direction, system shall operate at rated speed and shall stop at the nearest available floor, open its doors for passengers to exit and then remain on this floor with its doors opened, all safety features shall remain operational during system operation. When normal power is restored or emergency power from generator supply operates before the lift has reached the next available floor, the lifts operating on emergency battery power shall stop at the next available floor and be automatically removed from service. Emergency battery power is then to be disconnected and normal power or emergency power from the generator shall be applied to the lifts. In case of emergency supply is connected; only one lift of each group, unless otherwise shown on the drawings, in addition to all fire fighter lifts shall be operated from the emergency power supply, and shall respond to car and landing calls. After restoration of normal power supply all lifts shall resume normal service automatically. Batteries shall be sealed lead acid type.

E. Excess Load: Load-weighing device installed in car shall prevent car from starting in either direction if maximum loading is exceeded (adjustable from 100% - 110% of full load capacity and set at 100%). Buzzer shall sound and an 'overweight' light shall be illuminated until car is below maximum load. Excess load shall cause car to by-pass landing calls if car is loaded above normal but within an acceptable load limit.

F. Overload Bypass: excess load shall cause car to by-pass landing calls if car is loaded above normal but within an acceptable load limit. Load capacity shall be set at 70% (adjustable from 60 - 80% of full load capacity).

G. Distributed Parking: When cars are not required for response to calls, they are parked with doors closed and distributed in predetermined zones throughout the building. One zone shall include the main floor and adjacent floors; remaining floors shall be divided into approximately equal zones.

H. Independent Service: Keyswitch in car-control station removes car from group operation and allows it to respond only to car calls. Key cannot be removed from keyswitch when car is in independent service. When in independent service, doors close only in response to door close button.

I. Fire Emergency Service: meet local civil defense regulations for lifts fire emergency operating conditions. Fire emergency operation mode of lifts shall be activated via the following:

1. Actuation of fireman key switch at the main fire control room.
2. Actuation of fireman key switch at the main lobby of the fire fighter lift.
3. Automatic through the fire alarm system.
4. Fire Emergency Operation: through fireman key switch or fire alarm system shall be as follows:

    a) When a lift fire key-operated switch is put in the "on" position or a fire signal is received from the fire alarm system, all relevant lifts which are on automatic service shall return non-stop to the main landing floor and the doors shall open and remain open.
    b) Car(s) travelling away from the main landing floor shall stop at the next available floor without opening their doors and return directly to the main landing floor.
    c) For cars equipped with automatic power-operated doors, standing at a floor other than the main landing floor with doors open, the doors shall close immediately and the car shall proceed to the main landing floor.
    d) Door reopening devices for power-operated doors which are sensitive to smoke, heat or flame shall be rendered inoperative.
    e) All car and landing floor call buttons shall be rendered inoperative and all call registered lights and direction lanterns shall be switched off and remain inoperative.
    f) The activation of fire alarm detection device in any lift hoist way shall cause all lifts having any equipment located in the hoist way and any associated lifts in a group automatic operation, to return non-stop to the main landing floor and their doors shall open and remain open.
    g) The activation of fire alarm detection device in any lift machine room shall cause all lifts having any equipment located in that machine room, and any associated lifts of a group

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automatic operation, to return non-stop to the main landing floor and their doors shall open and remain open.

h) The activation of fire alarm detection device in any lift hoist way shall cause all lifts having any equipment located in the hoist way and any associated lifts in a group automatic operation, to return non-stop to the main landing floor and their doors shall open and remain open.

i) If the fire alarm detection device at the main landing floor is activated, the cars shall return non-stop to an alternate level, approved by the concerned authority, and their doors shall open and remain open. The operation of the lift requires the manual resetting of the fire alarm system.

j) When the switch is in the "off" position the lift shall revert to normal operation.

J. Fire Fighter Lifts: only fire fighter lifts can resume operation under fire emergency conditions from car push buttons by activation of the car fire emergency key switch. The car fire emergency switch shall be effective only when the hall fireman key switch at the main landing floor is in the "on" position or the fire alarm detection device (if provided) is activated and the car is at the main landing floor. The car key shall be removable only in the "off" position. When the car key switch is in the "on" position, it shall bring the lift into the emergency mode. Emergency operation from inside the car shall be cancelled when the hall fireman key switch is switched to the "off" position with the car at the main landing floor

K. Fire Fighter Lifts: operation under fire conditions shall be as follows after activation of the car fire emergency key switch:

1. The lift shall be operable only by a person in the car.
2. The lift shall not respond to landing floor calls.
3. The opening of power operated doors shall be controlled only by continuous pressure of the "open" button and if the button is released prior to the doors reaching the fully open position, the doors shall automatically reclose. Open doors shall be closed by either the registration of a car call button or by pressure on door "close" button.

L. When sprinklers are installed in the hoistway, control closet, or machinery spaces, a means to automatically disconnect the main line power supply of the affected lift prior to the application of water is to be provided. Smoke detectors shall not be used to activate sprinklers in hoistways, control closets, or machinery spaces or to disconnect the main line power supply.

120.090 LIFT OPERATION MODES

A. General: Provide manufacturer's standard microprocessor operation systems as required to provide type of operation indicated.

B. Push Button control, without attendant, with Automatic Doors: call push is to be provided at each landing served, together with 'lift coming' illuminated signal. In the car, a push is to be provided for each floor served, marked with appropriate floor designation. Calls by momentary pressure on 'floor' pushes in car or pushes at landing are to be registered and is to automatically close door(s) and start lift in direction corresponding to first registered call. Lift is to then answer registered car and landing calls in sequence in one direction and then in the other. On arrival at required floor, door(s) are to open automatically. After door(s) have remained open for an adjustable time, they are to close again automatically, and lift is to answer other registered calls. Non-interference relay is to be incorporated so that a delay of 3 to 5 seconds can be imposed on operation of car and landing calls after car has stopped at floor. Priority is to be given to car push buttons so that after car has stopped at floor, landing calls are rendered inoperative for 5 to 12 seconds.

C. Collective-Selective Group Control: Each lift group shall operate under one control system, handling all landing calls collectively and selectively. It shall be possible for each lift to be switched to attendant operation, removing it from the group. Lift control system shall be so arranged that appropriate car responds to landing calls by automatic selection, and systematic spacing of cars is maintained to minimize delays. Direction in which car will travel shall be determined by calls stored in system. 'Up' and 'down' directional call pushes shall be provided at each landing served by bank, together with 'call registered' illuminated signal for each push. 'Up' or 'down' push only shall be provided at terminal landings. In each car, a push shall be provided for each floor served, marked with appropriate floor designation. When lifts are switched to passenger operation, calls by

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momentary pressure on 'floor' pushes in car or pushes at landings shall be registered in control system and automatically and selectively cause closing of respective car door and start car in direction of first registered call. Lift shall collectively answer registered car and landing calls in sequence in one direction and then in the other. Having answered all calls stored in system, one car shall return automatically to park at main floor, with doors open, and other car(s) shall remain at floor last reached. When any lift of a group is switched to attendant operation, car shall respond to car calls and landing calls stored in system, but car shall start when attendant presses 'start' button. When attendant presses 'pass' button, landing calls are by-passed but remain registered. When attendant presses 'reverse' button, car shall stop and travel in opposite direction. Unanswered calls shall remain registered. 'Pass' and 'reverse' buttons shall be inoperative in passenger operation mode.

D. Supervisory System For Group Control: Lifts shall operate as one group by a microprocessor controlled supervisory system, automatically regulating movement of cars according to various traffic requirements, classified in five conditions: System automatically adjusts to demand changes for different traffic conditions including heavy incoming, heavy two-way, heavy outgoing, and light off-hours as variations of normal two-way traffic.

1. 'Off-peak and balanced traffic': Generally two way and inter-floor traffic.
2. 'Up-peak': when traffic is predominantly incoming.
3. 'Down-peak': when traffic is predominantly outgoing.
4. 'Light traffic': when traffic is intermittent such as outside normal working hours.
5. 'Night service'.
6. Selection of traffic condition and regulation of movement of cars shall be made automatically according to number and frequency of calls registered in system. In no case are two lifts to answer same directional landing call.

E. Supervisory System For Group Control:

1. During 'off-peak', lifts shall operate as group collective-selective.
2. During 'up-peak', all lifts, except one, shall answer only car calls, and travel directly back to main floor immediately after all calls have been answered; one lift shall also answer 'up' and 'down' landing calls.
3. During 'down-peak', all lifts, except one, shall answer car calls and landing 'down' calls, and travel directly up to highest registered landing call immediately they become free at main landing; one lift shall also answer 'up' landing calls; 'down-peak' operation shall incorporate feature which automatically divides operation into two stages:

    a) Stage 1: Dispatching of cars shall be modified to suit prevailing out-of-balance demand.
    b) Stage 2: If out-of-balance trend continues or becomes more predominant a 'zoned operation' shall be brought in.

4. During 'zoned operation', car or cars in lower zone are, in their upward journey, to operate with high call reversal; 'zoned operation' shall continue until Stage 2 peak condition ceases, when low cars shall revert to Stage 1 operation.
5. During 'light traffic', motor generator sets shall shut down after outstanding calls have been answered, and for a predetermined time when call is registered; motor generator of one car shall restart when call is registered, and others shall restart when calls become more frequent.
6. Arrangements shall be incorporated so that any one car may be left in operation for 'night service'; dispatching system is then to be inoperative and car shall start in response to first car or landing call.

F. Supervisory System For Group Control: At least one car shall be brought back to main floor and remain there with doors open, car lights on and 'this lift' sign illuminated. Other cars arriving at main floor, after all passengers have left, shall remain with doors closed while there is another car with 'this lift' sign illuminated. When first car leaves then second car becomes 'this lift'. Change-over from passenger to attendant control shall be by switch in supervisory panel at main floor.

120.100 LIFT COMMUNICATION SYSTEM

A. Intercom: provide an intercommunication system for all lifts. System shall provide two-way communication between the lift car stations and the master stations.

B. Station Types: the system shall have the following stations:

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1. Master station in the main fire control room.
2. Master station in the main security/control room.
3. Master station at the lift machine room/control station at last floor for machine room less type.
4. Slave station above each lift car.
5. Slave station in each lift pit.
6. Slave station in each lift car

C. Car Station shall have a loudspeaker and a microphone to provide hands-free communication. The station shall be installed behind the car operating panel.

D. Master Station shall be provided with selector push buttons, annunciator lights for each connected station, speaker microphone, volume control and function buttons. The intercom system shall include test button to verify audio circuit path.

E. Car Intercom Call: an intercom call shall be placed from the lift car station by pressing the emergency alarm push button. This action shall cause the lamp in the corresponding button of all the designated master stations to flash and an intermittent tone to be heard.

120.110 SPECIAL REQUIREMENTS

A. Handicapped and Persons with Disability Requirements: passenger lift design shall include the following requirements:

1. Locate the alarm button and car call buttons on the car operating panel where possible as required by EN81-70 for handicap requirements.
2. Provide car control buttons and hall push buttons with tactile marking, the tactile marking shall be in compliance with EN81-70.
3. The centre line of the hall push button stations shall be 1100 mm above the floor where possible.
4. The hall lanterns shall sound once for the "up" direction and twice for the "down" direction.

B. Connection to the Building Management System: coordinate with the Building Management System (BMS) supplier and provide all necessary interface devices, dry contacts, transducers, instruments, etc. for connection of the required points to the BMS as specified or indicated in the BMS schedules.

C. Building Management System (BMS) provisions:

1. Refer to the BMS specifications, in coordination with the BMS specialist, for the data points and functions to be provided as part of the integration with the BMS. The BMS will provide operation management functionality for the lift where all monitoring and control points will be accessible by the BMS.
2. A demonstration shall be performed for the Engineer, as a proof that a bench test integration has been conducted between the system and the BMS platform prior to materials submission.
3. The lift shall be interfaced with the BMS through one of the following open standards communication protocols: BACnet, LonTalk, Modbus, OPC.
4. Provide all Servers, Network Interface Unit, communication gateways, accessories, etc... as required to ensure seamless integration between the system and the BMS.
5. Provide confirmation and full compliance report that the system shall be seamlessly integrated with the BMS as per the functions and requirements stipulated in this specification section and the BMS specification section, prior to any commitment.
6. Provide comprehensive and complete documentations regarding the requirements of the integration with the BMS, including databases, Object IDs and description, component addresses and any other pertinent information.
7. Validate all functions, with the BMS integrator, prior hand over.

120.120 REMOTE MONITORING AND COMMAND SYSTEM

A. Remote monitoring System: shall be provided and shall be located in BMS room.

B. System Architecture shall be based on a "Client-Server" configuration.

C. Servers, the Contractor shall design Servers architecture to fulfil, as a minimum, the following requirements:

1. Separation of database and application servers.
2. Dual-redundant servers in clusters for high availability.

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D. Servers Configuration:

1. The servers shall consist of dual, redundant servers. The intent is to prevent a single system point of failure.
2. The servers shall be identical, with one server acting as the primary and the second server acting as a hot stand-by server with automatic fail over capabilities.
3. The two servers shall maintain synchronized databases automatically. Upon loss of communication of the system with the primary host, the secondary server shall automatically assume the control of the system and become the primary server. Upon the re-establishment of communication with the server, the two servers shall automatically resynchronize without requiring re-booting of the servers.

E. The Contractor shall design servers that are able to cope with the foreseen workload:

1. The Contractor shall indicate the percentage increase of workload that the servers will be able to cope with.
2. The Contractor shall configure the required servers.
3. Requirements for servers (in terms of operating system, memory, CPU, screen size, resolution, storage, associated peripheral I/O devices, etc.) shall be submitted for Engineer's review/approval.

F. Servers

1. For minimum requirements of servers and related ancillaries, refer to:

a) Division W, Section "Virtual Servers Environment (VSE)".
b) Division W, Section "Computers & Related Peripherals".

G. System: computerized Lift Remote Monitoring and Command System complete including software and necessary data and communication network shall be provided for all lifts and escalators / moving walks of the project. All material and installation requirements of the communication network within the project shall be coordinated with lift supplier and shall be as per his requirements. Panel shall be located at BMS room, unless otherwise advised by the Client.

H. Software Package: the software shall cover all required monitoring and command functions, maintenance program requirements in coordination with the maintenance contract and necessary communications and interfaces with lift control system and other concerned systems.

I. System: lift remote monitoring and command system shall include a state-of-art, multi-color high resolution, minimum 24-inch display, personal computer with adequate mass storage capacity and a dedicated high quality printer. Monitoring and command facility shall be provided in each machine room, either through local fixed or portable computer unit. Equipment specifications shall be submitted for the Engineer’s approval.

J. Operator Workstation:

1. For minimum requirements of workstations and related peripherals, refer to Division W Section "Computers & Related Peripherals".

K. Monitoring Display: the system shall be capable of displaying the information in graphic or tabular displays as follows:

1. Graphic Status Display of an elevation representation for all cars in a group shall be shown in the same time for each group including the following as a minimum:

a) Floor status.
b) Group operational mode.
c) Car status.
d) Hall calls.
e) Date and time, building and group identification.

2. Tabular Status Display shall include as a minimum the same information as above except for registered hall and car calls.

L. Lift Alarm and Event Data Display: lift remote monitoring and command system shall monitor various discrete signals from the lift system and retain a log of alarms, faults and events. An audible

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alarm with adjustable volume and silencer shall automatically sound at each lift failure and or alarm condition.

M. Security Display and Command Operation: system shall display one group at a time and shall allow through keyboard commands modification of the security status of the car in the group, including floors the car is allowed to serve, floors that the car is secured from serving and floors that are cut out from having hall calls registered from them.

N. Interactive Lift Operations Display and Control: the ability to use the keyboard to initiate and display interactive lift, moving walk and escalator operations, including but not limited to, the following shall be provided:

1. Display faults and events.
2. Alarm messages.
3. Any other special operations allowed by the manufacturer.

O. Traffic Analysis Display: system shall be capable for viewing various reports generated from the data including the following as a minimum:

1. Total number of hall calls (up/down).
2. Average hall call times (up/down).
3. Maximum hall call time.
4. Number of car calls per car.
5. Number of hall and car calls per landing (up/down).
6. Average hall call time per landing.
7. Histogram of registration times.
8. Record of all events alarms.
9. Statistics showing percentages of time in different operation modes.
10. Playback of the graphic status display.

P. Historical Data: system shall be capable of providing full historical data for minimum 30 days, and tendering for modes of operations, failures, alarms, maintenance requirements as a minimum.

Q. Command Control Feature: Proved password protected command control software to enable building manager to control operation of lifts using the following functions:

1. Floor lockout (hall and car simultaneously).
2. Car call lockout (all cars within a group).
3. Parking operation- remove car from group and place at predetermined zoning floor.
4. Independent operation- remove car from group to respond to car calls only.
5. VIP operation: send any car to any floor and remain there for period of three minutes reassigning all other calls to different cars automatically.

R. Documentation: provide complete documentation, illustrating functions of software systems, including the following:

1. General system overview.
2. High-level functional description.
3. I-O tables and charts, showing output bus and input signals.
4. Applicable technical manuals for adjusting, including drive control adjustment, terminal characteristics for diagnostic work, and user procedures.

120.130 LIFT FIRE CONTROL PANEL

A. Lift fire control panel: design and provide lift fire control panel, with display of car position and door status, group and unit operating modes, and operating status for all lifts. In addition to indicators for each fire fighter car, when running on in-car fire emergency mode. Panel shall be located at main fire control room of the building. Panel shall consist of two sections, an analogue type section for the fire fighter lifts (for simultaneous indication of all lifts) and a digital type section for all other lifts comprising a PC with LCD screen. Panel shall be complete with all necessary controls, indicators, wiring, unless otherwise proposed by the supplier and approved by the engineer.

B. Control Devices: provide the following control devices as a minimum:

1. Fireman key switch, to select between normal (off) and emergency fire operation (on) modes,

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2. Communication master station.

120.140 SOURCE QUALITY CONTROL

A. Factory acceptance tests shall be performed for equipment under this Contract and shall be witnessed by the Engineer.

B. Factory acceptance tests shall include complete checking and testing for 10% of the Project's lifts, minimum one unit of each type, according to requirements of the specified regulations and standards, as well as special requirements, finishes, software and controls. Selection of lifts for witness test shall be randomly carried out by the Engineer.

C. Test procedure and program shall be submitted for approval prior to test conduction, by at least 14 days. Factory witness test shall include, at Contractor's expenses, all test expenses, business class air tickets, five stars Hotel full accommodation, and transportation, for two persons from the Engineer's or Employer's side.

D. Comply with related quality requirements as specified in Division A.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division A Specification Sections, apply to this Section.

210.000 RELATED SECTIONS

A. Related Requirements include the following:

1. Division E Section "Accessories Cast Into In Situ Concrete" for setting sleeves, inserts, and anchoring devices in concrete.
2. Division F Section "Brick/ Block Walling" for setting sleeves, inserts, and anchoring devices in masonry.
3. Division G Section "Structural Steel Framing" for attachment plates, angle brackets, and other preparation of structural steel for fastening guide-rail brackets.
4. Division G Section "Structural / Carcassing Metal / Timber" for attachment plates, angle brackets, divider beams, and other steel framing for supporting guide-rail brackets.
5. Division G Section "Structural Steel Framing" for hot-rolled steel subsills and entrance frames that are a part of steel frame.
6. Division Z Section "Purpose made metalwork" for hot-rolled steel subsills and entrance frames.
7. Division L Section "Stairs/ ladders/ walkways/ handrails/ balustrades", for handrail and foot railing.
8. Division L Section "Fixed utilitarian access systems" for pit ladders.
9. Division Z Section "Purpose made metalwork" for combination hall push-button stations.
10. Division M Section "Painting Clear Finishing" for epoxy / polyurethane painting.
11. Division M Sections for finish flooring in lift cars, ceiling, mirrors, glazing where applicable.
12. Division U Sections for ventilating hoistways and machine rooms.
13. Division W Section "Central Control / Building Management".
14. Division V Section "Basic Electrical Materials and Methods".
15. Divisions V & Y Sections for electrical service to lifts, including fused disconnect switches, standby power source, and transfer switch.
16. Division W Sections for security card access equipment used to restrict lift use.

PART 3 PRODUCTS AND WORKMANSHIP

300.000 MATERIALS

300.010 STANDARD COMMERCIAL PRODUCTS

A. Refer to Division A Section "Product Requirements".

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310.000 QUALITY MANAGEMENT

310.010 QUALITY ASSURANCE

A. Products, materials and equipment shall demonstrate compliance with requirements specified in Division A Section "Product Requirements".

B. Installer Qualifications: Engage the lift manufacturer or an experienced Installer approved by the lift manufacturer who has completed lift installations similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

C. Manufacturer Certificates: Signed by lift manufacturer certifying that hoistway, pit, and machine room or control closet layout and dimensions, as shown on Drawings, and electrical service, as shown and specified, are adequate for lift system being provided.

D. Mean Time between Failures (MTBF) shall not exceed one failure per year. This time shall be considered for corrective maintenance and not preventive.

E. Components shall be designed in accordance with usual engineering practice and calculation codes, taking into account all failure modes considered in the Code. These shall be made of materials, free of defects, with adequate strength and of suitable quality. Materials classified as harmful shall not be used.

F. Sustainability Requirements: Comply with indicated Codes and sustainability targets and requirements specified in Division A Sustainability sections, as related to lifts, for Energy Efficiency:

310.020 DELIVERY, STORAGE AND HANDLING

A. Packing and Shipping: Deliver materials, components and equipment in original protective shipping containers with labels intact and legible.

B. Delivery on Site: Do not deliver materials, components and equipment on site until adequate protected storage facilities are available or for direct installation.

C. Storage and Protection: Store materials, components and equipment above ground, under cover and in a well-ventilated protected area. Comply with manufacturer's recommendations concerning temperature and relative humidity limitations during storage.

D. Install certified "shock-guards' on the equipment before shipping from the factory and shall be retained in place till unpacked at site and inspected by Engineer, to ascertain whether the "shock-guard" has been activated by any shock/impact during shipment.

310.030 COORDINATION

A. Coordinate installation of sleeves, block outs, lift equipment with integral anchors, and other items that are embedded in concrete or masonry for lift equipment. Furnish templates, sleeves, lift equipment with integral anchors, and installation instructions and deliver to project site in time for installation.

B. Coordinate locations and dimensions of other work relating to electric traction lifts including pit ladders; sumps and floor drains in pits; entrance subsills; electrical service; and electrical outlets, lights, and switches in hoistways, pits, and machine rooms.

310.040 WARRANTY

A. Provide complete system warranty in which Manufacturer, Installer, and Contractor are jointly and severally liable and agree to repair or replace all defective components of the warranted item. Warranty shall include both, materials and workmanship, warranty shall cover:

1. Defective materials and installation.
2. Failure to comply with requirements stated in technical specifications.
3. Structural failures including, but not limited to, excessive deflection.
4. Faulty operation of movable parts such as hardware.

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5. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
6. Delamination of exterior or interior facing materials.
7. Making good and installation and finishing all items that are disturbed and that may be required due to repair or replacement of defective items. Coordinate with Employer, manufacturer, and installer of adjacent disturbed items to ensure that their warranty is not cancelled due to the repair work

B. Warranty Period: 1 year from the date of Substantial Completion.

310.050 MAINTENANCE AND SUPPORT

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months full maintenance service by skilled, competent employees of the lift Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper lift operation at rated speed and capacity. Use parts and supplies as used in the manufacture and installation of original equipment.

1. Perform maintenance, including emergency callback service, during normal working hours.

a) Response Time: 1-1/2 to 2 hours for trouble calls and 30 minutes for trapped passengers.

2. Include 24-hour-per-day, 7-day-per-week emergency callback service.

a) Response Time: 1-1/2 to 2 hours for trouble calls and 30 minutes for trapped passengers.

B. Continuing Maintenance Proposal: Submit a continuing maintenance proposal from Installer to Employer, in the form of a standard two-year maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

310.060 EXTRA MATERIAL

A. Generally: Supply loose equipment, spare parts and accessories as required for normal operation and routine maintenance of the systems and as detailed by the Contractor in his offer for spare parts and accessories.

B. Tools and Accessories: Supply tools and equipment required for routine checking, maintenance, testing and control of installations, with appropriate portable measuring and test instruments.

C. Identification: Parts shall be packed in sealed plastic bags with identifying labels and factory part list numbers.

320.000 SUBMITTALS

A. Product Data (For each lift): Include capacities, sizes, performances, operations, safety features, finishes, and similar information. Include product data for car enclosures, hoistway entrances, and operation, control, and signal systems.

B. Sample Warranty: Copy of manufacturer's proposed warranty, stating obligations, remedies, limitations, and exclusions.

C. Country of origin of the Lift shall be indicated in addition to the country of origin of main components including drive, motor, controller, etc.. Complete documentation for factory manufacturing the equipment shall be submitted including but not limited to local and international experience, quality certificates, quality assurance plan, and organization.

D. Sustainable Design Submittals: All related Sustainable Product Data as detailed in Division A Sustainability sections, as applicable.

E. Shop Drawings (For each lift): Show plans, elevations, sections, and large-scale details indicating service at each landing, machine room layout, coordination with building structure, and relationships with other construction. Indicate variations from specified requirements, maximum dynamic and static loads imposed on building structure at points of support, and locations of equipment and signals. Include maximum and average power demands.

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F. Mock-up: Prior to starting construction and after obtaining the shop drawings approval, Contractor shall provide a mock-up for Employer / Engineer approval. Such mock-up must reflect the approved details and finishes and cabin design. The related comments posted by the Employer/Engineer shall be reflected on the mock-up and the shop drawings and resubmitted for approval. One mock-up shall be provided per type of lift. Mock-up shall be identical to the final product.

G. Construction work shall not proceed until final approval of material/equipment, Shop drawings and mock-up obtained.

H. Samples: For exposed finishes for car, hoistway doors, and signal equipment; 75 mm square samples of sheet materials; and 100 mm lengths of running trim members.

I. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Engineers and Employers, and other information specified or required by Engineer.

J. Maintenance Manuals: For each different electric traction lift, including operation and maintenance instructions, parts listing with sources indicated, recommended parts inventory listing, emergency instructions, and similar information. Include all diagnostic and repair information available to manufacturer's and installer's maintenance personnel. Submit for Employer's information at project Closeout as specified in Division A.

K. Warranties: Warranties specified in this Section.

L. Inspection and acceptance certificates and operating permits as required by governing authorities for normal, unrestricted lift use.

M. Type test reports shall be submitted for the following:

1. Examination type test certificate which shall include a full description of the product, cross reference for the individually certified components, test conditions, test procedures, test results versus allowable limits according to the code EN81-20/50.
2. Landing door fire test to EN 81-58 and EN 1363.
3. Speed governor.
4. Safety gear.
5. Buffer.
6. Brake (main and auxiliary) system.
7. Traction Ropes.
8. Freight lift loading class.
9. Safety circuits.
10. Unintended car movement protection means.

In case, recent type test reports, within 5 years are not available for any of the above components, new type test shall be carried out on the relevant components.

N. As-Built Drawings: At project Closeout, submit record drawings of installed lifts, in accordance with requirements of the specification, Division A.

330.000 EXECUTION

330.010 EXAMINATION

A. Prior to commencing lift installation, examine lift areas, with Installer present, for compliance with requirements, installation tolerances, and other conditions affecting performance of lift work. Examine hoist ways, hoist way openings, pits, and machine rooms, as constructed; verify critical dimensions; and examine supporting structure and other conditions under which lift work shall be installed. Notify Contractor in writing of any dimensional discrepancies or other conditions detrimental to the proper installation or performance of lift work. Do not proceed with installation until unsatisfactory conditions have been corrected.

330.020 INSTALLATION

A. Comply with manufacturer's instructions and recommendations.

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B. Coordination: Coordinate lift work with work of other trades for proper time and sequence to avoid construction delays. Use established benchmarks, lines, and levels to ensure dimensional coordination of the Work. Coordinate equipment installations with the building construction to prevent alteration to structure and cutting of holes and chases after equipment installation has started. Ensure provision of pit screen separators between adjacent lifts and for screening off counterweight to a height of 2 m from bottom of pit for safety of maintenance personnel.

C. Assembly: equipment is, as far as possible, to be factory assembled, wired and tested. Site work shall be limited to installation and assembly of parts dismantled at factory for transportation, or otherwise to work not possible at factory.

D. Workmanship: Carry out work in a neat, workmanlike and efficient manner in accordance with specified requirements. Installation shall be performed by skilled personnel, specialized in lift installation, who are in the permanent employment of the manufacturer or manufacturer's authorized dealer.

E. Accessibility: Install equipment so that it is readily accessible for operation, maintenance and repair.

F. Builder's Work: Carry out all builder's work necessarily required in connection with installation of lifts, including but not limited to, forming or cutting chases, rebates, etc., grouting, supports, steelwork, scaffolding, etc. Provide convenience power, lighting and other services required, from assigned terminal points, to carry out construction work.

G. Secure machine beams to structural steel and set machines in position for proper alignment with car and counterweight.

H. Lift Shafts: Ensure that entrance shaft wall is in same vertical plane as face of landing doors and that whole face is perfectly smooth.

I. Fixing Lift Guide Rails: Keep rails in proper alignment using steel splice plates of adequate strength. Verticality of rail shall be within 0.2% tolerance. Space fixing brackets to minimize rail vibration during operation, and at not more than 2.5 m centres.

J. Painting: Protect unfinished metalwork by painting, unless technically undesirable. Painting shall include thorough cleaning of metal, application of rust inhibiting prime coat and two finishing coats of approved enamel.

K. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts designed to effectively prevent transmission of vibrations to structure and thereby, eliminate sources of structure-borne noise from lift system.

L. Lubricate operating parts of systems, including ropes, as recommended by manufacturers.

M. Alignment: Coordinate installation of hoistway entrances with installation of lift guide rails for accurate alignment of entrances with cars. Where possible, delay final adjustment of sills and doors until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.

N. Set sills flush with finished floor surface at landings. Coordinate with other trades to facilitate and ensure proper grouting of sills.

330.030 FIELD QUALITY CONTROL

A. Acceptance Testing: Upon nominal completion of lift installation and before permitting use (either temporary or permanent) of lifts, perform acceptance tests as required and recommended by the "Code" and governing regulations and agencies.

B. Advise Employer, Engineer, and authorities having jurisdiction in advance of dates and times tests shall be performed on lifts.

1. Field Quality Tests:

a) After installation is complete and before hand-over, carry out acceptance tests as required and recommended by the standards (refer to EN 81-20/50 and inspection check list which shall be submitted by the lift supplier subject to be reviewed and approved by the engineer) and governing regulations and authorities. Carry out any other tests the Engineer may

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require to check safety and compliance of installation with the Specification. Tests are to be witnessed by the Engineer, and, if required, by the concerned Authority.

b) Equipment Failure: Repair and make good any damage to equipment caused by tests or damage to building caused by failure of any part of the installation, to the satisfaction of the Engineer.

2. Final Acceptance Test: Final acceptance of installation shall be carried out, as required and recommended by the "Code" and governing regulations (local and international) and agencies, only after all field quality tests are complete and all submittals and required certificates approved by the Engineer. Above Field quality tests are to be repeated, in front of same attendees. Compliance of workmanship and equipment with specification is to be checked.

330.040 DEMONSTRATION AND TRAINING

A. Train Employer's maintenance personnel on procedures and schedules for maintaining, operating, adjusting, troubleshooting, and servicing lifts. Refer to Division A sections related to Demonstration and Training.

1. Make a final check of each lift operation, with Employer's maintenance personnel present, just prior to Substantial Completion. Determine that operation systems and devices are functioning properly.

330.050 PROTECTION

A. Temporary Use: Do not use lifts for construction purposes unless otherwise approved in writing by Engineer, and cars are provided with temporary enclosures, either within finished cars or in place of finished cars, to protect finishes from damage.

B. Provide full maintenance service by skilled, competent employees of the lift Installer for lifts used for construction purposes. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper lift operation at rated speed and capacity. Use parts and supplies as used in the manufacture and installation of original equipment.

C. Provide protective coverings, barriers, devices, signs, or other procedures to protect lifts. If, despite such protection, lifts become damaged, engage lift Installer to restore damaged work so that no evidence remains of correction work. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

D. Provide final protection and maintain conditions, in a manner acceptable to lift manufacturer and Installer, that ensure lifts are without damage or deterioration at the time of Substantial Completion.

330.060 LIFT SCHEDULE

A. The Contractor shall coordinate the final space requirements (shaft dimensions, pit depth, overhead height, etc.) with the architectural layout and details. Ensure full compatibility. Any contradiction shall be raised to the Engineer.

B. All finishes shall be subject to Engineer/ID approval.

C. Passenger and service elevator Lift schedules shall be provided as per the below format

D. Lift No.:

1. Type of Service: Passenger/service.
2. Number of Passengers:
3. Load: …..kg.
4. Speed: …..m/sec.
5. Machine Room-Less.
6. Total Travel: As per AR Layout.
7. Floors Served: As per AR Layout.
8. Entrance Door Type:

a) Car: Automatic Sliding.
b) Landing: Automatic Sliding.

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c) Single Entrance.

9. Main Parking Floor: Ground Floor.
10. Car Dimensions:

    a) Width: …… m.
    b) Depth: ……..m.
    c) Height:…… m.

11. Door Dimensions:

    a) Width: ……m.
    b) Height: ….. m.

12. Hoistway Dimensions (for two elevator in each bank):

    a) Width: …….m.
    b) Depth: ……m.
    c) Construction : ……..

13. Pit Depth : …… m.
14. Overhead: ……..m.
15. Additional Features: CCTV.
16. Finishes:

    a) Car:

        1) Walls: ……..(subject to Engineer's approval).
        2) Doors: …….(subject to Engineer's approval).
        3) Ceiling: ……(subject to Engineer's approval).
        4) Flooring: ……..
        5) Lighting: LED.
        6) Handrail (from 2 sides): ……..(subject to Engineer's approval).
        7) Mirror: ……..

    b) Control and Position Indicator Plates: Hairline stainless steel grade 304.
    c) Landing Doors: Hairline stainless steel grade 304.
    d) Landing Sills: Hairline stainless steel grade 304.

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X11 - ESCALATORS

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. This Section includes heavy duty escalators.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Regulatory Requirements: In addition to local governing regulations, comply with the applicable provisions of the following Standards, referred to as the "Code":

1. BS EN 115-1, "Safety of Escalators and moving walks. Construction and installation".
2. BS 5656, "Safety rules for the construction and installation of escalators and passenger conveyors and moving walks".
3. All normative references listed in EN 115-1.
4. Power supply and electrical installations shall conform to the local power authority practices.
5. All electric power installations shall comply with relevant IEC Standards and BS 7671 "IET Wiring Regulations".
6. Nominal characteristics of all equipment forming part of the electrical works shall be specified to conform to the relevant International Electro-technical Commission (IEC) Standards and the International Standards Organization (ISO).
7. Electromagnetic compatibility (EMC): EN 12015 (emission) and EN 12016 (immunity).
8. <**Insert other local codes>**.

110.020 DEFINITIONS AND ABBREVIATIONS

A. Escalators shall be Heavy Duty Escalators: Escalators designed to be used in heavy traffic flow and heavy passenger loadings

B. Defective Escalator Work: Operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; the need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.

C. Escalator Width: The width of the step treads.

120.000 SYSTEM DESCRIPTION

120.010 PERFORMANCE REQUIREMENTS

A. Rated Speed: 0.5 m/s.

B. Inclination Angle: 30°.

C. Components Life Time: Escalator components shall be designed to give a minimum life time of 140,000 hours for heavy duty escalators, based on the load profile specified by code without replacement of major parts and capable of operating continuously in either direction.

D. Operation Time: Escalator shall be designed for a minimum operation time of 20h/day (for Heavy Duty Escalator under load profile described in the code.

E. Braking Performance: Engineer, fabricate, and install escalators to stop the escalator in the up-running mode at a rate no greater than that allowed by the "Code" for the down-running mode.

F. Step width: 1000mm.

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120.020 COMPONENTS AND ACCESSORIES

A. General: Provide high-traffic escalators complying with requirements. Unless otherwise indicated, provide heavy-duty components as indicated in manufacturers' publications and as required for a complete escalator.

1. Provide escalators with three flat steps at top and bottom landings. Fabricate exposed metalwork, including deck covers, balustrade panels, and trim to provide surface flatness equivalent to stretcher-leveled standard of flatness and sufficient strength for indicated use; increase metal thickness or reinforce with concealed stiffeners, backing materials, or both, as necessary. Support joints with concealed stiffeners as needed to hold exposed faces of adjoining sheets in flush alignment.

B. Supporting Truss: Welded steel lattice-girder construction, designed to support inherent weights of escalators, transport load of 5000 N/m2 and dynamic loads (load surface = useable width of escalator x distance between support points). Sag or downward bending of supporting structure, when under load, shall not exceed 1/1000 for heavy duty and extra heavy duty escalators of free distance between supports. Insulation pads shall be provided at both ends of main truss to prevent noise and vibration transmission to building structure. The truss shall be designed in such a way to accommodate the load without the need of intermediate supports unless otherwise specified or shown on the drawings.

C. Machine Soffit: Smooth steel plate, 4 mm thick, welded and made oil-tight to side members of main truss, installed beneath step band over whole area of escalator, and having oil drain pit in bottom reversing station.

D. Floor Coverings: Stationary parts of escalator shall be heavy duty aluminum profiles. Groove beds of floor surfaces shall be black anodized, and upper surfaces shall be smoothed to the base metal frames, and set flush with finished floor. Floor coverings in area of machine installations shall be squarely seated and tighty fitted to prevent noise development.

E. Steps: Die-cast, corrosion proof, aluminum alloy with front edges grooved vertically so that edges of tread surfaces enmesh in grooves. Tread and front-edge surfaces of steps shall not end in a groove under balustrade skirting. Front edge between tread and front face shall be rounded or bevelled. Four support rollers to each step shall be at least 75 mm outside diameter and shall run on ball bearings completely encapsulated against dust and water (RS sealing), with lifetime lubrication, without lube nipples. Step chain rollers shall be fitted inside chain link plates, and shall be at least 75 mm diameter. Running treads (tires) of rollers shall be non-ageing, hardwearing, noise-dampening and oil and acid-resistant synthetic rubber (e.g. NBR nitrile rubber). Treads shall be at least 15 mm thick and 20 mm wide. Rapid removal of steps shall be possible at both upper and lower ends of escalator without removing balustrade panels or skirting plates. Assembled steps and any attachments to steps are not allowed.

F. Step Color and Demarcation: Steps color shall be [natural] [silver] [black] with [no demarcation] [yellow plastic demarcation] [yellow paint demarcation].

G. Comb Plates and Combs: Comb segments shall be [die-cast aluminum alloy] [stainless steel], maximum 200 mm wide, easily exchanged, and with safety contacts on comb teeth. Combs shall be beveled (minimum 13 to 17 degrees of the angle) so that there is no danger of persons tripping when leaving escalator. Tread surface of comb plates shall be finished as floor coverings.

H. Handrails: Endless, high-quality vulcanized rubber composition with fabric insert/invisible connection and bubble free, sliding layer of nylon webbing and steel cord. Required frictional contact to handrail drive wheel shall be ensured by drive mechanism. Handrail guides shall be stainless steel with minimum breaking strength of 25 kN. Handrail color [Black] [as selected by the Engineer]. Handrails shall be marked with safety messages. Exact marking shall be as per the Employer’s requirements during execution.

I. Lighting: Provide four comb **[LED]** lights at each end, green [**LED**] tubes shall be provided under the steps at the two entrances of the escalators. [Other lighting arrangements can be provided if required by the Engineer e.g. continuous skirt lighting by LED lights, Handrail lighting & soffit spot lights. Provide direction indicator lights in balustrade newels at both upper and lower landings. Green light indicates entrance end, and red lights indicates exit end. When escalator is stopped, red lights are illuminated at both ends. Lighting details are subjected to Engineer’s approval.

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J. For lighting fixtures specifications, refer to Division V section "Interior Lighting".

K. Oil Drip Pan: Provide metal pan under full width and length of escalator to collect and hold oil and grease drippings from lubricated components. Design and fabricate drip pan to sustain a load of minimum 1.1 kN on a 0.9-sq. m area at any location without permanent deflection.

L. Bolted Connections: Secure bolts by self- locking nuts or locking rings. Only high-tensile bolts shall be used.

M. Corrosion Protection: Unless otherwise specified, main supporting truss shall be corrosion protected according to manufacturer standards subject to Engineer's approval. All traces of rust shall be thoroughly removed from steel components before painting.

N. Balustrades: Inner balustrades, skirtings, outer balustrades, central balustrades and floor coverings shall be as shown on Drawings, and to the following specification:

1. Balustrades shall be designed to be [slim line type and made of toughened safety glass with thickness of 10 mm . Handrail guides shall be practically invisible and sit centrally on the glass panel. The balustrade shall be all glass with [vertically/parallel subject to Engineer's choice] arranged panels, without supports. Glass panel joints shall be in line with the inner and outer decking joints. The trims between glass panels and inner and outer deckings shall be made of aluminum profiles black colour] [made of laminated panels, visible side hairline or etched stainless steel (finish according to Engineer's choice)]
2. Inner and outer deckings shall be made of at least 2mm thick stainless steel (finish according to Engineer's choice). Deckings shall be done in the curved version, mitered version is not allowed.
3. Skirtings are made of minimum 2 mm thick [stainless steel plate][steel plate coated with a black antifriction Teflon compound]. Skirtings shall be provided with brush deflectors, made of aluminum anodised black holders.
4. Visible sides and underside of each escalator shall be cladded with [**etched**] [**hairline**] stainless steel panels of 1.5 mm thickness. Joints of these cladding-panels shall be in line with joints of balustrade panels. Finish shall be according to the Engineer's choice.
5. Height of the balustrade shall be minimum1100 mm] over the entire length of the escalator.
6. Above characteristics are indicative. Contractor to coordinate with Engineer prior to starting any equipment manufacturing.
7. Adjacent Escalators: Provide stainless steel in-fill panels. A protection shall be provided to stop children entry to the fill panel. The protection shall match the surroundings.
8. Balustrade panels shall be attached to permit easy removal for inspection, lubrication, and adjustment of safety devices.
9. Balustrade panels shall be sized so that not more than two (2) persons shall be required to remove a panel and without the aid of special handling equipment.

O. Stainless Steel: Type 304 shall be used

P. Track Radius: upper landing [1m for commercial escalators] [1.5m or 2.6m for heavy duty escalators] [2.6m or 3.6m for extra heavy duty escalators]. Lower landing [1.0m for commercial] [1.0m or 2m for heavy duty escalators] [2.0m for extra heavy duty escalators].

Q. Outdoor Escalators and semi outdoor shall have the following extra characteristics as a minimum:

1. Stainless steel handrail guides,
2. Step chain covers to minimize dirt and water ingress,
3. Weatherproof electrical system,
4. Water drain in lower truss section,

R. Fabricate oil drip pan from galvanized-steel sheet. Provide drain and oil/water separator in oil drip pan. Coordinate with builder's work to provide the pit drain.

S. Outdoor Escalators steel truss shall be hot dipped galvanized after fabrication. [semi outdoor escalators installed in severe environments and as required by engineer shall have hot dipped galvanized truss after fabrication].

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T. Sound Level: Escalators shall be designed to operate at or below a sixty five (65) decibels sound level, measured at 1 m from the surface of the machinery and at a height of 1.6 m from the floor plate, with the escalator operating normally, either free running or under load. For multiple escalator installations, the noise measurements shall be made with only one (1) escalator unit in operation, but with the entire installation complete and in operating condition. An ambient level not to exceed forty-nine (49) decibels shall be maintained prior to units being turned on.

U. Escalators shall be provided with protection covers to secure and provide the necessary protection for escalators' moving handrail, belt and balustrade to ensure children at most safety and to reduce climbing, hanging and clothes-gripping incidents that exposure to risks.

V. Protection covers shall be provided at start and end points of the escalators so hangings and clothes-gripping incidents will be avoided. And also protection covers shall be added to the balustrade so climbing will not be possible.

W. Protection cover shall be made of [Final selected protection cover shall be approved by the Engineer/Architect.

X. If the escalator is required to operate in both directions and has facility for removable barriers in unrestricted area the absence/presence of these barriers shall be detected to prevent wrong positioning of the barrier resulting in operation towards the barrier.

Y. Device shall be provided to detect the removal of the barrier when the escalator is running, and the absence/presence of a removable barrier intended to prevent access of shopping trolleys and carts and shall permit starting away from the inserted barrier.

120.030 DRIVE UNIT

A. Generally: Complete drive unit including the handrail driving system shall be according manufacturers standard located within the upper truss envelop. All drive components shall be easily accessible. Provide an automatic lubrication system for drive chains, and include drive chain monitoring contacts. Each escalator shall be equipped with an auxiliary brake. An oil level switch shall be provided to monitor the gearbox oil level. The overall mechanical efficiency of the complete drive including motor shall not be less than 90%. Details of the complete drive system shall be submitted with the tender.

B. Input stage of drive shall be a worm-gear for noise suppression. Worm shaft shall be case hardened and ground, and gear rim of worm wheel shall be hard-wearing special bronze.

C. Manual emergency drive shall be provided at upper station, accessible without removal of steps or any part of drive systems.

D. Drive unit shall be variable voltage variable frequency (VVVF, Regenerative) type for nominal speed, standby speed, service speed, soft start and soft stop. Drive and motor shall be suitable for continuous operation.

E. Bearings used in machine transmissions shall be top quality roller/ball bearings with minimal noise development. Plain friction or sleeve bearings shall not be used.

F. Handrail drive shall be automatically tensioned and shall ensure synchronization with step band speed. Asynchronous running of handrails shall not exceed 2% of step band speed.

G. Electric Motor: Totally enclosed, fan cooled, protection IP 54, fitted with low noise life-time lubricated roller/ball bearings, especially designed for escalators according to the manufacturer standard. Motor shall be provided in Class F insulation with temperature rise not exceeding Class B limits. Duty factor shall be S1 or S5, as recommended by manufacturer and approved by the Engineer.

H. Intended reversal of the direction of travel shall be possible, in accordance with EN 115-1 requirements.

I. Brakes Generally: drive machine shall be equipped with an electro-mechanical service brake operating on the high speed shaft of the motor. Brake shall be held off electrically and spring applied to ensure "fail-safe" operation. Action of the break shall be smooth. Electrical monitoring for wear

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of brake lining and brake lifting shall be included in the design of both the service break and auxiliary break. The brake linings shall be asbestos-free. Details shall be submitted with the tender.

J. Service Brake: Constant torque, self-adjusting, and servo-operated in case of heavy, to exert necessary braking torque for direction of travel, with braking force created by pressure spring. Upon tripping of any safety device, brake shall engage immediately and bring escalator to a smooth stop. An equivalent electronic system is allowed. Details shall be submitted with tender.

K. Safety brake shall be provided for all escalators, in addition to service brake, on main drive shaft assembly, and shall engage after an adjustable time-lag setting. Safety brake shall be actuated by brake release solenoid, manually resettable only, and shall engage in the event of power failure, by stop push button, or operation of any safety device.

L. Step Guides: Guides for step chains and step rollers shall be hot-dip galvanized steel sections with smooth and even surfaces. Joints shall be formed diagonally in direction of travel. Guides shall be designed so that front edges of emerging steps, and rear edges of disappearing steps, follow a horizontal path at least equal to depth of the number of flat steps specified at landings. Guides shall ensure that gap between step and balustrade skirting does not exceed 4 mm at either side or 7 mm at both sides cumulatively.

M. Step Chains: High precision rolled, flat link, hardened chains, provided in pairs of equal length. Pins, sleeves and rollers shall be case-hardened and ground. Spur racks or gear chains shall not be used. Step chains and chain pins shall be 16 mm minimum diameter. Material for chain pins shall be 23 Cr Mo B33E (E stands for case hardened) Material for chain plus shall be 16 Mn Cr 5E. Chain pitch shall not exceed 135 mm.

N. Chain Tensioner: Constant and even pressure shall be maintained by adjustable compression springs. Chain tensioning wheels shall be seated in precision slides (ball and prism guides). Even tensioning of step band chains shall be ensured.

O. Expansion joints: to balance the movement between escalators and building structure special sliding and fixed supports shall be provided.

P. For Remote Monitoring system, interface with BMS,. Refer to Lift specification section "Electric Traction Lifts".

120.040 CONTROL PANEL

A. Generally: Electrical installation comprises connection of all wiring systems from control cabinet to various control devices.

B. Control Cabinet: Each escalator shall have individual instrument and control gear cabinet, protection IP 21 for Indoor Escalators, shed mounted and located within upper escalator station (drive station), and comprising main circuit breaker, motor control gear, protective devices, relays, cut-off and tripping displays, etc. To ensure that there is no interference with other electrical systems (EMC) within the building, the design has to be according to international recommended standards.

C. Control equipment shall include, in addition to the above, a fault finding digital panel with warning lights, located behind lockable cover in upper balustrade newel. Each safety contact shall be connected to one warning light. Cancelling is only to be possible using a separate switch in the balustrade. Key operated switch (up/down) for starting escalator shall be provided in handrail newel.

D. The controller shall be of the micro-processor-type. The controller includes a diagnostic system with an alphanumeric display (LED). This display shall monitor and indicate the general operational status of the escalator, statistical information and status of all safety devices. The system shall be designed in such a way that all this information can be transmitted via a serial interface to the “conveying systems central monitoring system”.

E. Control Voltage: V single phase AC, 48VDC or less.

F. Running time meter shall be provided.

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G. Main Circuit Breaker: Thermal magnetic type, with inverse time-overcurrent, instantaneous and adjustable earth fault protection. Circuit breaker shall be lockable, and with shunt trip coil for safety trips.

H. Terminal Identification: All terminals shall be marked. All cables shall have coding colours and numbered ferrules.

I. Wiring shall be arranged neatly and clearly in conduits and terminated on shrouded terminal blocks.

J. Electrical cables in main truss shall be moisture and heat resistant and flame retardant with PVC/E insulation and sheathing, and shall have 1000 V rating.

K. Maintenance power circuit at 400 V, **50**Hz, shall be provided for power and lighting sockets. Dual sockets for power and lighting shall be provided at drive and tensioning stations.

L. Control circuit breaker shall be provided at tensioning station.

M. Maintenance sockets for plugging in maintenance push button control device for testing operation of escalator shall be provided at upper and lower stations, with maintenance control extension device and sufficient cable length.

120.050 SAFETY DEVICES

A. Operation: Safety devices shall automatically interrupt power supply to drive motor and brake, thereby inducing braking of escalator.

B. Devices to be provided are as follows:

1. Emergency stop-buttons, at upper and lower newels, located in a suitable place to prevent the inadvertent actuation. Additional emergency stop buttons and locations shall be provided in accordance with EN 115-1 requirements.
2. Step run-in monitors in area of comb plates and at point of entry of steps into combs, which shall induce safety braking of step chain when a foreign body enters between comb and step.
3. Missing step monitors actuated in case step chain without step is installed.
4. Step sag monitors which shall stop escalator when a step sinks by more than [**3**] [**6**] <**Other>** mm due to incorrectly formed or damaged steps or rollers; step shall stop before reaching comb run-in point.
5. Motor overload earth-fault and phase-unbalance protection and excessive temperature protection by thermistors in motor coils.
6. Handrail safety device to stop escalator immediately should foreign bodies become wedged between handrail and inlet points in balustrade newels.
7. Step chain monitors to stop escalator in the event of any chain breaking or becoming excessively elongated.
8. Excessive speed and unintended reversal relay.
9. Service brake-monitoring contact against failure or phase change.
10. Handrail Speed Device: Sounds an alarm if handrail speed varies from step speed by more than 15% and stops escalators if this condition lasts more than 2 seconds.
11. Skirt Obstruction Device: Stops escalator if an object gets caught between skirt panels and steps as the step approaches the comb plate.
12. Handrail Entry Device: Stops escalator if an object gets caught between the handrail and the handrail guard or, alternatively, if an object approaches the area between the handrail and the guard.
13. Broken main drive chain device located on the main drive chain actuated in case of main drive chain breaking or abnormal tension of main drive chain.
14. Floor plate switches located under floor plate of both landings, actuated when floor plate is removed, and escalator cannot move.
15. Machine cover switch located on the machine actuated when motor cover is removed, and escalator cannot be operated.
16. Fire Alarm contact to stop the escalator in case of external signal.
17. Provision for installation of fire alarm detectors in escalator pits.
18. Brushes at handrail entries.

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19. A fault-finding device shall be provided in the newels, capable of producing indications of the following data:

    a) Date, time, and cause of escalator stoppages.
    b) The fault indication shall remain visible until reset by an authorized person.

20. Pictograph notices and signs which shall be provided by the escalator supplier as per code requirements and shall be installed by the main contractor.
21. Traffic lights at top and bottom to indicate running direction. Type LED, Bicolor; location in inner decking.
22. Comb lights.
23. Speed sensors at both newels.
24. Direction change key switches.

120.060 SOURCE QUALITY CONTROL

A. Factory acceptance tests shall be performed for equipment under this Contract and shall be witnessed by the Engineer.

B. Factory acceptance tests shall include complete checking and testing for 10% of the Project's escalators, minimum one unit of each type, according to requirements of the specified regulations and standards, as well as special requirements, finishes, software and controls. Selection of escalators for witness test shall be randomly carried out by the Engineer.

C. Test procedure and program shall be submitted for approval prior to test conduction, by at least 14 days. Factory witness test shall include, at Contractor's expenses, all test expenses, business class air tickets, five stars Hotel full accommodation, and transportation, for two persons from the Engineer's or Employer's side.

D. Comply with related quality requirements as specified in Division A.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division A Specification Sections, apply to this Section.

210.000 RELATED SECTIONS

A. Related Requirements include the following:

1. Division E Section "In Situ Concrete Construction Generally" for setting sleeves, inserts, and anchoring devices in concrete.
2. Division G Section "Structural Steel Framing" for attachment plates, angle brackets, and other preparation of structural steel for supporting escalators.
3. Division Q Section "Site Street Furniture Equipment" for metal bollards.
4. Division L Section "Stairs ladders walkways handrails balustrades" for balustrade glazing where applicable.
5. Division L Section "Doors Shutters Hatches" for wall and ceiling access panels and access doors in escalator enclosures.
6. Division W Section " Digital, Addressable Fire Alarm System " for smoke detectors that activate escalator alarm and, after at least 15 seconds, cause the interruption of power to the escalator motor and brake and for connection to escalator controllers.
7. Division W Section "Central Control / Building Management".
8. Division V Section "Basic Electrical Materials and Methods".
9. Division V and Y Sections for electrical service to escalators, including fused disconnect switches.
10. Division X Section "Electric Traction Lifts" for remote monitoring and command system.

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PART 3 PRODUCTS AND WORKMANSHIP

300.000 MATERIALS

300.010 STANDARD COMMERCIAL PRODUCTS

A. Refer to Division A Section "Product Requirements".

310.000 QUALITY MANAGEMENT

310.010 QUALITY ASSURANCE

A. Products, materials and equipment shall demonstrate compliance with requirements specified in Division A Section "Product Requirements".

B. Installer Qualifications: Engage the escalator manufacturer or an experienced Installer approved by the escalator manufacturer who has completed escalator installations similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

C. Source Limitations: Obtain escalators, through one source from a single manufacturer.

D. Conformity to Standards: Contractor shall be responsible for the provision of a complete installation in total conformity with the Standards. It is the Contractor’s responsibility to provide all Standards requirements even if not accounted for in this Specification. It is the Contractor's responsibility to coordinate with the Engineer on the issues related to the safety of the installations.

E. In the event of a conflict between any of the above applicable or reference Standards, the more stringent requirements shall take precedence.

F. In case Contractor proposes part of equipment in accordance with other Standards, then detailed comparison documents including one original copy (in English – translation to English should be the approved one by the Standard originating Committee) of the latest edition of the referred to Standard (and related annexes) shall be submitted for Engineer's approval. These documents shall detail discrepancies and advantages of offer. Submittals shall be preceded by a written approval of the Engineer on such. However, the Employer and the Engineer reserves the right to accept or reject such proposals.

310.020 DELIVERY, STORAGE AND HANDLING

A. Packing and Shipping: Deliver materials, components and equipment in original protective shipping containers with labels intact and legible.

B. Delivery on Site: Do not deliver materials, components and equipment on site until adequate protected storage facilities are available or for direct installation.

C. Storage and Protection: Store materials, components and equipment above ground, under cover and in a well-ventilated protected area. Comply with manufacturer's recommendations concerning temperature and relative humidity limitations during storage.

D. Install certified “shock-guards’ on the equipment before shipping from the factory and shall be retained in place till unpacked at site and inspected by Engineer, to ascertain whether the “shock-guard” has been activated by any shock/impact during shipment.

310.030 COORDINATION

A. Coordinate installation of sleeves, block outs, escalator equipment with integral anchors, and other items that are embedded in concrete or masonry for escalator equipment. Furnish templates, sleeves, escalator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.

B. Coordinate sequence of escalator installation with other work to avoid delaying the Work.

C. Coordinate locations and dimensions of other work relating to escalators including sumps and floor drains in pits, electrical service, and electrical outlets, lights, and switches in pits.

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310.040 EXTRA MATERIALS

A. Generally: Supply loose equipment, and accessories as required for normal operation and routine maintenance of the escalator(s) and as detailed by the Contractor in his offer for spare parts and accessories, for two years continuous operation. Tools required for the diagnosis and configuration of the equipment shall be provided.

B. Spare parts shall include, but not limited to the following, with minimum one piece of each part:

ESCALATOR SPARE PARTS	(%) Qty. of Total Escalator Number
Escalator step assembly	2
Step roller	10
Step spacer	10
Step chain and accessories	2
Step chain roller	10
Drive chain	2
Drive chain extension accessories	2
Roller for handrail support	10
Comb and accessories	2
Interface relay	2
Lifting solenoid	2
Retaining spring	2
Motor protection switch	2
Stop / start switch	2
Proximity sensor	5
Speed monitor impulse counter	1
Limit switches	2
Emergency stop button & buzzer	2
Brake shoe	5
Brake magnet	2
Sliding rail	1
Rubber pads links	2
Handrail entry	2
Tension chain sensor	1

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C. Tools and Accessories: Supply tools and equipment required for routine checking, maintenance, testing and control of installations, with appropriate portable measuring and test instruments.

D. Identification: Parts shall be packed in sealed plastic bags with identifying labels and factory part list numbers.

310.050 WARRANTY

A. Provide complete system warranty in which Manufacturer, Installer, and Contractor are jointly and severally liable and agree to repair or replace all defective components of the warranted item. Warranty shall include both, materials and workmanship, warranty shall include:

1. Defective materials and installation.
2. Failure to comply with requirements stated in technical specifications.
3. Structural failures including, but not limited to, excessive deflection.
4. Faulty operation of movable parts such as hardware.
5. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
6. Delamination of exterior or interior facing materials.
7. Making good and installation and finishing all items that are disturbed and that may be required due to repair or replacement of defective items. Coordinate with Employer, manufacturer, and installer of adjacent disturbed items to ensure that their warranty is not cancelled due to the repair work

B. Warranty Period: 3 year from the date of Substantial Completion.

320.000 SUBMITTALS

A. Product Data (For each escalator): Include capacities, sizes, performances, safety features, finishes, and similar information.

B. Sample Warranty: Copy of manufacturer's proposed warranty, stating obligations, remedies, limitations, and exclusions.

C. Country of origin of the Escalator assembly shall be indicated in addition to the country of origin of main components including drive, motor, controller, steps, etc.. Complete documentation for factory manufacturing the equipment shall be submitted including but not limited to local and international experience, quality certificates, quality assurance plan, and organization.

D. Sustainable Design Submittals: All related Sustainable Product Data as detailed in Division A Sustainability sections, as applicable.

E. Shop Drawings (For each escalator): Show plans, elevations, sections, and large-scale details indicating coordination with building structure and relationships with other construction. Indicate variations from specified requirements, maximum dynamic and static loads imposed on building structure at points of support, and power requirements. Indicate access and ventilation for escalator machine space and well ways.

F. Construction work shall not proceed until final approval of material / equipment and shop drawings obtained.

G. Samples for Initial Selection: For exposed materials e.g. color selection, handrail rubber, inlet indicators, etc..

H. Test Certificates/Calculations: To be submitted for the following:

1. The maximum deflection of supporting structure under full passenger load.
2. Breaking strength of handrail.
3. Breaking strength of step chain.
4. Step load test.
5. Step / Landings alignment test.
6. Stamped calibrated step.

In addition to any other test required by the Engineer.

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I. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Engineers and Employers, and other information specified or required by Engineer.

J. Maintenance Manuals: For each different escalator, including operation and maintenance instructions, parts listing with sources indicated, recommended parts inventory listing, emergency instructions, and similar information. Include all diagnostic and repair information available to manufacturer's and Installer's maintenance personnel. Submit for Employer's information at project closeout as specified in Division A.

K. Warranties: Warranties specified in this Section.

L. Certificates and Permits: Provide Employer with inspection and acceptance certificates and operating permits as required by governing authorities for normal, unrestricted use of escalators.

M. As-built Drawings: At project Closeout, submit record drawings of installed escalators, in accordance with requirements of the specifications, Division A.

330.000 EXECUTION

330.010 EXAMINATION

A. Examine escalator areas, with Installer present, for compliance with requirements, installation tolerances, and other conditions affecting performance of escalator work. Examine supporting structure, machine spaces, and pits; verify critical dimensions; and examine conditions under which escalator work shall be installed. Do not proceed with installation until unsatisfactory conditions have been corrected.

1. For the record, prepare a written report, endorsed by the Installer, listing dimensional discrepancies and conditions detrimental to the performance of escalator work.

330.020 INSTALLATION

A. Comply with manufacturer's instructions and recommendations for work during installation.

B. Set escalators true to line and level, properly supported, and anchored to building structure. Use established benchmarks, lines, and levels to ensure dimensional coordination of the Work.

C. Adjust installed components for smooth, efficient operation, complying with required tolerances and free of hazardous conditions. Lubricate operating parts, including bearings, tracks, chains, guides, and hardware. Test operating devices, equipment, signals, controls, and safety devices. Install oil drip pan and check to ensure that no oil drips outside of pan.

D. Repair damaged finishes so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

E. Assembly: Equipment is, as far as possible, to be factory assembled, wired and tested. Site work shall be limited to installation and assembly of parts dismantled at factory for transportation, or otherwise to work not possible at factory.

F. Workmanship: Carry out work in a neat, workmanlike and efficient manner in accordance with the specified requirements. Installation shall be performed by skilled personnel, specialized in escalator installation, who are in the permanent employment of the manufacturer or manufacturer's authorized dealer.

G. Accessibility: Install equipment so that it is readily accessible for operation, maintenance and repair.

H. Builder's Work: Carry out all builder's work necessarily required in connection with installation of escalators, including but not limited to forming or cutting chases, rebates, etc., grouting, supports, steelwork, scaffolding, etc. Provide convenience power, lighting and other services required from assigned terminal points, to carry out construction work.

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I. Coordination: Coordinate equipment installations with the building construction to prevent alteration to structure and cutting of holes and chases after equipment installation has started.

J. Fire Protection: Coordinate installations with mechanical works, for provision of fire/smoke detection and fire fighting systems.

K. Painting: Protect unfinished metalwork by painting, unless technically undesirable. Painting shall include thorough cleaning of metal, application of rust inhibiting prime coat and two finishing coats of approved enamel.

330.030 FIELD QUALITY CONTROL

A. Tests: After installation is complete and prior to Substantial Completion, carry out all tests required by the Governing Regulations and Standards (refer to EN 115-1 requirements). Carry out any other tests the Engineer may require to check safety and compliance of installation with specified requirements. Tests shall be witnessed by the Engineer and, if required, by the authorities having jurisdiction.

B. Equipment Failure: Repair and make good any damage to equipment caused by tests, or damage to building caused by failure of any part of the installation, to the satisfaction of the Engineer.

C. Organization of Tests: Provide all labour, materials and instruments required for tests.

D. Before test run, ensure that step bands, skirtings and comb segments are in order, no foreign bodies are in or on escalator, all steps are fitted, main circuit breaker is in closed position, control switch is in on position, safety devices and protective switches are in operation, series of safety contacts are closed and manual control device is connected to inspection run power socket.

E. Test run shall include checking starting from installed service panel, reversing direction of running from manual control device and checking that actual running direction corresponds with direction setting, allowing running in each direction for several cycles. Any adjustments shall be made with inspection control device connected.

F. Testing operation of Safeties: In accordance with manufacturer's service and maintenance instructions, check all alarms and indicators and lubricating oil system against manufacturer's data.

G. After testing, check, and if necessary, re-adjust spring tensions on return shaft, handrail pretension, drive rollers, step inlet and outlet, sag, skirtings, gaps etc., brake stopping distance, and gear oil level.

H. Measurements: Measure motor current in both directions of escalator, and insulation resistance to truss or earth of motor circuit, control circuits, brake circuit, lighting circuits, pump circuit and any other circuits. Insulation resistance shall not be less than 20 M-ohms using a minimum 1000 V d.c. megger.

I. Acceptance Testing: Upon nominal completion of each escalator installation, and before permitting the use of escalators (either temporary or permanent), perform acceptance tests as required and recommended by the "Code" and by governing regulations or agencies.

330.040 DEMONSTRATION AND TRAINING

A. Engage a factory-authorized service representative to train Employer's maintenance personnel on procedures and schedules for maintaining, operating, adjusting, troubleshooting, and servicing escalators. Refer to Division A Sections related to Demonstration and Training.

1. Make a final check of each escalator operation, with Employer's maintenance personnel present, just prior to Substantial Completion. Determine that control systems, operation components and devices are functioning properly.

330.050 PROTECTION

A. At completion of escalator work, provide suitable protective coverings, barriers, devices, signs, or such other methods or procedures to protect escalator work from damage or deterioration. Maintain protective measures throughout remainder of construction period.

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330.060 ESCALATOR SCHEDULE

A. The Contractor shall coordinate the final space requirements (truss depth, pit depth, overall length, etc.) with the architectural layout and details. Ensure full compatibility. Any contradiction shall be raised to the Engineer.

B. Escalator No <INSERT Reference>:

1. Type **:** Indoor.
2. Conveying Height/Rise: …… m.
3. Inclination Angle: …….deg.
4. Step Width: ……m.
5. Number of Horizontal Steps: 3
6. Speed: …….m/sec.
7. Duty: heavy duty .
8. Track Radius (Lower Landing/Upper landing): …….
9. Intermediate Supports: [YES] [NO].
10. Overall Width: …… m.
11. Overall Length: …… m.
12. Upper Truss Depth: ……. m.
13. Pit Dimensions:

    a) Length: …… m.
    b) Width: …….. m.
    c) Depth: ……m.

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X13 - MOVING WALKS

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. This Section includes moving walks.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Regulatory Requirements: In addition to local governing regulations, comply with the applicable provisions of the following Standards, referred to as the "Code":

1. BS EN 115-1, "Safety of Escalators and moving walks. Construction and installation".
2. BS 5656, “Safety rules for the construction and installation of escalators and passenger conveyors and moving walks”.
3. All normative references listed in EN 115-1.
4. Power supply and electrical installations shall conform to the local power authority practices.
5. All electric power installations shall comply with relevant IEC Standards and BS 7671 “IET Wiring Regulations”
6. Nominal characteristics of all equipment forming part of the electrical works shall be specified to conform to the relevant International Electro-technical Commission (IEC) Standards and the International Standards Organization (ISO).
7. Electromagnetic compatibility (EMC): EN 12015 (emission) and EN 12016 (immunity).

110.020 DEFINITIONS AND ABBREVIATIONS

A. The following terms used on Drawings and in the Specification are synonymous and may be used interchangeably:

1. "Moving Walk", "Travellators" and "Auto Walk".

B. Moving Walk Width: The width of the exposed tread, to the next whole 10 mm. Clearance between handrails shall not be less than 203 mm more than the moving walk width.

C. Defective Moving Walk Work: Operation or control system failures; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; the need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.

120.000 SYSTEM DESCRIPTION

120.010 PERFORMANCE REQUIREMENTS

A. General: Provide moving walks consisting of power-driven, continuous treadways that are capable of conveying passengers safely at rated speeds and capacities along either a horizontal surface or an inclined ramp as indicated and that include support trusses, balustrades, floor plates, components, machines, safety and control devices, internal electrical wiring of units, graphics, and other components necessary to produce complete moving walk installations.

B. Rated Speed: 0.5 m/s.

C. Inclination Angle: **0-6°**

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D. Pallet width: 1000mmIn paragraph below, 100,000 hours can be accepted for commercial projects where heavy traffic is not required.

E. Components Life Time: Moving walk components shall be designed to give a minimum life time of [150,000 – 200,000 hours] based on the load profile specified by code without replacement of major parts and capable of operating continuously in either direction.

F. Operation Time: Moving walk shall be designed for a minimum operation time of [up to 22h/day] under load profile described in the code.

120.020 COMPONENTS AND ACCESSORIES

A. General: Provide heavy duty high-traffic moving walks complying with standards and requirements. Unless otherwise indicated, provide heavy-duty components as indicated in manufacturers' publications and as required for a complete moving walk.

1. Provide four flat pallet at both landings for inclined moving walk with inclination angle above 6°.

B. Supporting Truss: Welded steel construction, designed to support inherent weights of moving walks, transport load of 5000N/m2 and dynamic loads (load surface = useable width of moving walk x distance between support points). Sag or downward bending of supporting structure, when under load, shall not exceed 1/1000 of free distance between supports. Insulation pads shall be provided at both ends of main truss to prevent noise and vibration transmission to building structure.

C. Floor Coverings: Stationary parts of moving walk including ramps shall be heavy duty aluminum profiles. Groove beds of floor surfaces shall be black anodized, and upper surfaces shall be smoothed to the base metal frames, and set flush with finished floor. Floor coverings in area of machine installations shall be easily removable. Floor cover platings shall be squarely seated and tightly fitted to prevent noise development.

D. Pallets: Torsion-resistant design, one piece high tensile die-cast aluminum, at least 400 mm deep, with enmeshing front and rear edges. Transverse diagonal scoring with narrow grooves shall provide non-slip surface. Groove beds of pallet treads shall be black anodized, upper surfaces shall be smooth to base metal.

E. Comb Plates and Combs: Comb segments shall be [die-cast aluminum alloy] [stainless steel], maximum 200 mm wide, easily exchanged, and with safety contacts on comb teeth. Combs shall be beveled (minimum 13 to 17 degrees of the angle) so that there is no danger of persons tripping when leaving moving walk. Tread surface of comb plates shall be finished as floor coverings.

F. Handrails: Endless, high-quality vulcanized rubber composition with fabric insert/invisible connection and bubble free, sliding layer of nylon webbing and steel cord. Required frictional contact to handrail drive wheel shall be ensured by drive mechanism. Handrail guides shall be stainless steel with minimum breaking strength of 25 kN. Handrail color shall be [Black] [as selected by the Engineer]. Handrails shall be marked with safety messages. Exact marking shall be as per the Employer’s requirements during execution.

G. Handrails shall be disinfected in an efficient and environmentally friendly way, in order to avoid the rapid spread of bacteria and viruses that build up on them due to passenger use. Physical disinfection process is to be granted through providing UV LED lighting technology. UV device is to be installed invisibly inside the moving walks handrail system to ensure passenger safety.

H. Lubrication: Main drive chain, pallet band chains and handrail drive chain shall be connected to automatic lubricating system with electrical lube oil pump and dosing unit. Oil supply shall be sufficient for at least one month's operation. Float switch shall be provided to monitor oil level in reservoir and to give alarm to control cabinet in the event of low lubricant level. All bearing points of rotating components shall be fitted with roller/ball bearings, hermetically sealed against dirt and water. Where bearings require lubrication by grease guns, functional discharge openings shall be provided for used grease.

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I. Oil Drip Pan: Provide metal pan under full width and length of moving walk to collect and hold oil and grease drippings from lubricated components. Design and fabricate drip pan to sustain a load of 1.1 kN on a 0.9-sq. m area at any location without permanent deflection.

J. Bolted Connections: Secure bolts by self- locking nuts or locking rings. Only high-tensile bolts shall be used.

K. Corrosion Protection: Unless otherwise specified, main supporting truss shall be corrosion protected according to manufacturer standards subject to Engineer's approval. All traces of rust shall be thoroughly removed from steel components before painting.

L. Balustrades: Inner balustrades, skirtings, outer balustrades, central balustrades and floor coverings shall be as shown on Drawings, and to the following specification:

1. Balustrades shall be designed to be (finish according to the Engineer's choice)]
2. Skirtings are made of minimum 2 mm thick [stainless steel plate] [steel plate coated with a black antifriction Teflon compound]. Skirtings shall be provided with brush deflectors, made of aluminum anodized black holders.
3. Balustrade height shall be 1000 mm throughout the length of the moving walk.
4. Above characteristics are indicative. Contractor to coordinate with Engineer prior to starting any equipment manufacturing.
5. Adjacent Moving walks: Provide stainless steel in-fill panels. A protection shall be provided to stop children entry to the fill panel. The protection shall match the surroundings.

M. Deck Covers and Trim: [Satin stainless steel] [Polished stainless steel] [Gold-colored, satin stainless steel] [Gold-colored, polished stainless steel] [Satin bronze] <other finish specified by Engineer>.

N. Floor Plates: [die-cast aluminum alloy] [stainless steel], grooved or patterned surface.

O. Lighting: Provide four comb [LED] lights at each end, green [LED] tubes shall be provided under the pallets at the two entrances. [Other lighting arrangements can be provided if required by the Engineer e.g. continuous skirt lighting by LED lights, Handrail lighting]. Provide direction indicator lights in balustrade newels at both entrance and exit ends. Green light indicates entrance end, and red lights indicates exit end. When moving walk is stopped, red lights are illuminated at both ends. Lighting details are subjected to Engineer's approval.

P. For lighting fixtures specifications, refer to Division V section "Interior Lighting".

Q. Stainless Steel: Type 304 shall be used

R. Outdoor Moving walks and semi outdoor shall have the following extra characteristics as a minimum:

1. Exposed components from stainless steel unless otherwise indicated.
2. waterproof electrical system,
3. Provide drains, weeps, and drips to prevent water accumulation on horizontal surfaces and to direct water away from electrical equipment and moving parts.

S. Fabricate oil drip pan from galvanized-steel sheet. Provide drain and oil/water separator in oil drip pan. Coordinate with builder's work to provide the pit drain.

T. Outdoor Moving walk steel truss shall be hot dipped galvanized after fabrication. [Semi outdoor moving walk installed in severe environments and as required by engineer shall have hot dipped galvanized truss after fabrication].

U. Moving walks shall be provided with protection covers to secure and provide the necessary protection for moving handrail and belt to reduce clothes-gripping incidents that exposure to risks

V. Protection covers shall be provided at start and end points of the moving walks so hangings and clothes-gripping incidents will be avoided.

W. Protection cover shall be made of [transparent acrylic] [material and finish similar to the balustrade] <Insert material and finish>. Final selected protection cover shall be approved by the Engineer/Architect.

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120.030 DRIVE UNIT

A. Generally: Drive unit shall be self-contained, compact assembly, placed outside and in front of pallet band, and comprising motor (flange mounted to speed reducing gear box and resiliently coupled to drive input), service brakes and precision duplex chain mechanism to transmit motion to main drive shaft assembly comprising chain sprocket, wheels for main drive, pallet band drive wheels, handrail drive and safety brake. Details of this or alternative arrangements shall be submitted to the Engineer for approval.

B. Input stage of drive shall be a worm-gear for noise suppression. Worm shaft shall be case hardened and ground, and gear rim of worm wheel shall be hard-wearing special bronze.

C. Manual emergency drive shall be provided at drive station, accessible without removal of pallets or any part of drive systems.

D. Drive unit shall be variable voltage variable frequency (VVVF, Regenerative) type for nominal speed, standby speed, service speed, soft start and soft stop. Drive and motor shall be suitable for continuous operation.

E. Bearings used in machine transmissions shall be top quality roller/ball bearings with minimal noise development. Plain friction or sleeve bearings shall not be used.

F. Handrail drive shall be automatically tensioned and shall ensure synchronization with pallet band speed. Asynchronous running of handrail shall not exceed 2% of step band speed.

G. Drive station shall be easily accessible for servicing and repair. Hatches or doors shall be provided, finished flush to other panel sections when closed. Suitable ventilation system shall be included.

H. Electric Motor: Totally enclosed, fan cooled protection IP 54, fitted with low noise life-time lubricated roller/ball bearings, especially designed for moving walks according to the manufacturer standard. Motor shall be provided in Class F insulation with temperature rise not exceeding Class B limits. Duty factor shall be S1 or S5, as recommended by manufacturer and approved by the Engineer.

I. Intended reversal of the direction of travel shall be possible, in accordance with EN 115-1 requirements.

J. Service Brake: Constant torque, self-adjusting, and servo-operated, to exert necessary braking torque for direction of travel, with braking force created by pressure spring. Upon tripping of any safety device, brake shall engage immediately and bring moving walk to smooth stop.

K. Safety brake shall be provided for all moving walks, in addition to service brake, on main drive shaft assembly, and shall engage after an adjustable time-lag setting. Safety brake shall be actuated by brake release solenoid, manually resettable only, and shall engage in the event of power failure, by stop push button, or operation of any safety device.

L. Pallet and Chain Guides: Roller guide tracks shall extend for entire length of runway, and shall be hard drawn steel sections with special galvanization, supported at approximately 1.0 m centres. Joints between sections shall be formed diagonally in direction of travel. Joints connecting pallets and drive chains and all carrier rollers on pallets shall be maintenance free and fitted with life-time lubricated roller/ball bearings, encapsulated to be completely dust and water tight (RS sealing). Running treads of rollers shall be non-aging, hard wearing, noise dampening and oil and acid resistant material.

M. Drive Chains: High precision rolled, flat link, hardened chains, provided in pairs of equal length. Pins, sleeves and rollers shall be case-hardened and ground. Spur racks or gear chains shall not be used. Drive chains and chain pins shall be 14.6 mm minimum diameter. Material for chain pins shall be 23 Cr Mo B33. Chain pitch shall not exceed 135 mm.

N. Expansion joints: to balance the movement between moving walks and building structure special sliding and fixed supports shall be provided.

O. For Remote Monitoring system, interface with BMS, Refer to Lift specification section "Electric Traction lifts".

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120.040 CONTROL PANEL

A. Generally: Electrical installation comprises connection of all wiring systems from control cabinet to various control devices.

B. Control Cabinet: Each moving walk shall have individual instrument and control gear cabinet, protection IP 21 for indoor moving walksshed mounted and located within front moving walk station (drive station), and comprising main circuit breaker, motor control gear, protective devices, relays, cut-off and tripping displays, etc. To ensure that there is no interference with other electrical systems (EMC) within the building, the design has to be according to international recommended standards.

C. Control equipment shall include, in addition to the above, fault finding digital panel with warning lights, located behind lockable cover. Each safety contact shall be connected to one warning light. Cancelling is only to be possible using a separate switch. Key operated switch (up/down) for starting moving walk shall be provided in handrail newel.

D. The controller shall be of the micro-processor-type. The controller includes a diagnostic system with an alphanumeric display (LED). This display shall monitor and indicate the general operational status of the moving walk, statistical information and status of all safety devices. The system shall be designed in such a way that all this information can be transmitted via a serial interface to the "conveying systems central monitoring system".

E. Control Voltage: <**400AC Voltage**> V single phase, 48VDC or less.

F. Running time meter shall be provided.

G. Main Circuit Breaker: Thermal magnetic type, with inverse time-overcurrent, instantaneous and adjustable earth fault protection. Circuit breaker shall be lockable, and with shunt trip coil for safety trips.

H. Terminal Identification: All terminals shall be marked. All cables shall have coding colors and numbered ferrules.

I. Wiring shall be arranged neatly and clearly in conduits, and terminated on shrouded terminal blocks.

J. Electrical cables in main truss shall be moisture and heat resistant and flame retardant with PVC/E insulation and sheathing, and shall have 1000 V rating.

K. Maintenance power circuit of <400> V, 50 Hz, shall be provided for power and lighting sockets. Dual sockets for power and lighting shall be provided at drive and tensioning stations.

L. Control circuit breaker shall be provided at tensioning station.

M. Maintenance sockets for plugging in maintenance push button control device for testing operation of moving walk shall be provided at upper and lower stations, with maintenance control extension device and sufficient cable length.

120.050 SAFETY DEVICES

A. Operation: Safety devices shall automatically interrupt power supply to drive motor and brake, thereby inducing braking of moving walk.

B. Devices to be provided are as follows:

1. Emergency stop-buttons, at the two ends, located in a suitable place to prevent the inadvertent actuation. Additional emergency stop buttons and locations shall be provided in accordance with EN 115-1 requirements.
2. Pallet run-in monitors in area of comb plates and at point of entry of pallets into combs, which shall induce safety braking of pallet chain when a foreign body enters between comb and step.
3. Pallet band lock.
4. Pallet sag monitors which shall stop moving walk when a pallet sinks by more than 6 mm due to incorrectly formed or damaged pallets or rollers; pallet shall stop before reaching comb run-in point.
5. Motor overload earth-fault and phase-unbalance protection and excessive temperature protection by thermistors in motor coils.

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6. Handrail safety device to stop moving walk immediately should foreign bodies become wedged between handrail and inlet points in balustrade newels chain monitors to stop moving walk in the event of any chain breaking or becoming excessively elongated.
7. Excessive speed and unintended reversal relay.
8. Service brake monitoring contact against failure or phase change.
9. Skirt Obstruction Device: Stops moving walk if an object gets caught between skirt panels and pallets as the pallets approaches the comb plate.
10. Handrail Entry Device: Stops moving walk if an object gets caught between the handrail and the handrail guard or, alternatively, if an object approaches the area between the handrail and the guard.
11. Broken main drive chain device located on the main drive chain actuated in case of main drive chain breaking or abnormal tension of main drive chain.
12. Floor plate switches located under floor plate of both sides, actuated when floor plate is removed, and moving walk cannot move.
13. Machine cover switch located on the machine actuated when motor cover is removed, and moving walk cannot be operated.
14. Fire Alarm contact to stop the moving walk in case of external signal.
15. Brushes at handrail entries.
16. A fault-finding device shall be provided in the entrances, capable of producing indications of the following data:

    a) Date, time, and cause of moving walk stoppages.
    b) The fault indication shall remain visible until reset by an authorized person.

17. Pictograph notices and signs which shall be provided by the moving walk supplier as per code requirements and shall be installed by the main contractor.
18. Comb lighting: At the entrance and exit of moving walks flashing comb lights (LED) have to be provided.
19. Speed sensors to be provided at both newels.
20. Intermediate stop switches as per code.
21. Missing pallet safety switch.
22. Pallet demarcation light at both sides.

120.060 SOURCE QUALITY CONTROL

A. Factory acceptance tests shall be performed for equipment under this Contract and shall be witnessed by the Engineer.

B. Factory acceptance tests shall include complete checking and testing for 10% of the Project's moving walks, minimum one unit of each type, according to requirements of the specified regulations and standards, as well as special requirements, finishes, software and controls. Selection of moving walks for witness test shall be randomly carried out by the Engineer.

C. Test procedure and program shall be submitted for approval prior to test conduction, by at least 14 days. Factory witness test shall include, at Contractor's expenses, all test expenses, business class air tickets, five stars Hotel full accommodation, and transportation, for two persons from the Engineer's or Employer's side.

D. Comply with related quality requirements as specified in Division A.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division A Specification Sections, apply to this Section.

210.000 RELATED SECTIONS

A. Related Requirements include the following:

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1. Division E Section "In Situ Concrete Construction Generally" for setting sleeves, inserts, and anchoring devices in concrete.
2. Division G Section "Structural Steel Framing" for attachment plates, angle brackets, and other preparation of structural steel for supporting moving walks.
3. Division Q Section "Site Street Furniture Equipment" for metal bollards.
4. Division L Section "Stairs ladders walkways handrails balustrades" for balustrade glazing where applicable.
5. Division L Section "Doors Shutters Hatches" for wall and ceiling access panels and access doors in moving walk enclosures.
6. Division W Section " Digital, Addressable Fire Alarm System " for smoke detectors that activate moving walk alarm and, after at least 15 seconds, cause the interruption of power to the moving walk motor and brake and for connection to moving walk controllers.
7. Division W Section "Central Control / Building Management".
8. Division V Section "Basic Electrical Materials and Methods".
9. Division V and Y Sections for electrical service to moving walks, including fused disconnect switches.
10. Division X Section “Electric Traction Lifts” for remote monitoring and command system.

PART 3 PRODUCTS AND WORKMANSHIP

300.000 MATERIALS

300.010 STANDARD COMMERCIAL PRODUCTS

A. Refer to Division A Section "Product Requirements".

310.000 QUALITY MANAGEMENT

310.010 QUALITY ASSURANCE

A. Products, materials and equipment shall demonstrate compliance with requirements specified in Division A Section "Product Requirements".

B. Installer Qualifications: Engage the moving walk manufacturer or an experienced Installer approved by the moving walk manufacturer who has completed moving walk installations similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

C. Source Limitations: Obtain moving walks through one source from a single manufacturer.

D. Conformity to Standards: Contractor shall be responsible for the provision of a complete installation in total conformity with the Standards. It is the Contractor’s responsibility to provide all Standards requirements even if not accounted for in this Specification. It is the Contractor's responsibility to coordinate with the Engineer on the issues related to the safety of the installations.

E. In the event of a conflict between any of the above applicable or reference Standards, the more stringent requirements shall take precedence.

F. In case Contractor proposes part of equipment in accordance with other Standards, then detailed comparison documents including one original copy (in English – translation to English should be the approved one by the Standard originating Committee) of the latest edition of the referred to Standard (and related annexes) shall be submitted for Engineer's approval. These documents shall detail discrepancies and advantages of offer. Submittals shall be preceded by a written approval of the Engineer on such. However, the Employer and the Engineer reserves the right to accept or reject such proposals.

310.020 DELIVERY, STORAGE AND HANDLING

A. Packing and Shipping: Deliver materials, components and equipment in original protective shipping containers with labels intact and legible.

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B. Delivery on Site: Do not deliver materials, components and equipment on site until adequate protected storage facilities are available or for direct installation.

C. Storage and Protection: Store materials, components and equipment above ground, under cover and in a well-ventilated protected area. Comply with manufacturer's recommendations concerning temperature and relative humidity limitations during storage.

D. Install certified “shock-guards’ on the equipment before shipping from the factory and shall be retained in place till unpacked at site and inspected by Engineer, to ascertain whether the “shock-guard” has been activated by any shock/impact during shipment.

310.030 COORDINATION

A. Coordinate installation of sleeves, block outs, moving walk equipment with integral anchors, and other items that are embedded in concrete or masonry for moving walk equipment. Furnish templates, sleeves, moving walk equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.

B. Coordinate sequence of moving walk installation with other work to avoid delaying the Work.

C. Coordinate locations and dimensions of other work relating to moving walk including sumps and floor drains in pits, electrical service, and electrical outlets, lights, and switches in pits.

310.040 EXTRA MATERIALS

A. Generally: Supply loose equipment, [**spare parts**] and accessories as required for normal operation and routine maintenance of the moving walk(s) and as detailed by the Contractor in his offer, for two years continuous operation. Tools required for the diagnosis and configuration of the equipment shall be provided.

B. Spare parts shall include, but not limited to the following, with minimum one piece of each part:

MOVING WALKS SPARE PARTS	(%) Qty. of Total Moving Walks Number
Moving walk pallet assembly	2
Pallet chain and accessories	2
Pallet chain roller	10
Drive chain	2
Drive chain extension accessories	2
Roller for handrail support	10
Comb and accessories	2
Interface relay	2
Lifting solenoid	2
Retaining spring	2
Motor protection switch	2
Stop / start switch	2
Proximity sensor	5
Speed monitor impulse counter	1

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Limit switches	2
Emergency stop button & buzzer	2
Brake shoe	5
Brake magnet	2
Sliding rail	1
Rubber pads links	2
Handrail entry	2
Tension chain sensor	1

C. Tools and Accessories: Supply tools and equipment required for routine checking, maintenance, testing and control of installations, with appropriate portable measuring and test instruments.

D. Identification: Parts shall be packed in sealed plastic bags with identifying labels and factory part list numbers.

310.050 WARRANTY

A. Provide complete system warranty in which Manufacturer, Installer, and Contractor are jointly and severally liable and agree to repair or replace all defective components of the warranted item. Warranty shall include both, materials and workmanship, warranty shall include:

1. Defective materials and installation.
2. Failure to comply with requirements stated in technical specifications.
3. Structural failures including, but not limited to, excessive deflection.
4. Faulty operation of movable parts such as hardware.
5. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.
6. Delamination of exterior or interior facing materials.
7. Making good and installation and finishing all items that are disturbed and that may be required due to repair or replacement of defective items. Coordinate with Employer, manufacturer, and installer of adjacent disturbed items to ensure that their warranty is not cancelled due to the repair work.

B. Warranty Period: **3**year from the date of Substantial Completion.

320.000 SUBMITTALS

A. Product Data (For each moving walk): Include capacities, sizes, performances, safety features, finishes, and similar information.

B. Sample Warranty: Copy of manufacturer's proposed warranty, stating obligations, remedies, limitations, and exclusions.

C. Country of origin of the moving walk assembly shall be indicated in addition to the country of origin of main components including drive, motor, controller, pallets, etc.. Complete documentation for factory manufacturing the equipment shall be submitted including but not limited to local and international experience, quality certificates, quality assurance plan, and organization.

D. Sustainable Design Submittals: All related Sustainable Product Data as detailed in Division A Sustainability Sections, as applicable.

E. Shop Drawings (For each moving walk): Show plans, elevations, sections, and large-scale details indicating coordination with building structure and relationships with other construction. Indicate variations from specified requirements, maximum dynamic and static loads imposed on building structure at points of support, and power requirements. Indicate access and ventilation for moving walk machine space and wellways.

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F. Construction work shall not proceed until final approval of material / equipment and shop drawings obtained.

G. Samples for Initial Selection: For exposed materials e.g. color selection, handrail rubber, inlet indicators, etc..

H. Test Certificates/Calculations: To be submitted for the following:

1. The maximum deflection of supporting structure under full passenger load.
2. Breaking strength of handrail.
3. Breaking strength of pallet chain.
4. Pallet load test.
5. Pallet / Landings alignment test.

In addition to any other test required by the Engineer.

I. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of Engineers and Employers, and other information specified or required by Engineer.

J. Maintenance Manuals: For each different moving walk, including operation and maintenance instructions, parts listing with sources indicated, recommended parts inventory listing, emergency instructions, and similar information. Include all diagnostic and repair information available to manufacturer's and Installer's maintenance personnel. Submit for Employer's information at project closeout as specified in Division A.

K. Warranties: Warranties specified in this Section.

L. Certificates and Permits: Provide Employer with inspection and acceptance certificates and operating permits as required by governing authorities for normal, unrestricted use of moving walks.

M. As-built Drawings: At project Closeout, submit record drawings of installed moving walks, in accordance with requirements of the specifications, Division A.

330.000 EXECUTION

330.010 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide [**12 months**] full maintenance service by skilled, competent employees of the moving walk Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper moving walk operation at rated speed. Use only parts and supplies as used in the manufacture and installation of original equipment.

1. Include 24-hour-per-day, 7-day-per-week emergency callback service.

a) Response Time: [**2 hours or less**]

330.020 EXAMINATION

A. Examine moving walk areas, with Installer present, for compliance with requirements, installation tolerances, and other conditions affecting performance of moving walk work. Examine supporting structure, machine spaces, and pits; verify critical dimensions; and examine conditions under which moving walk work shall be installed. Do not proceed with installation until unsatisfactory conditions have been corrected.

1. For the record, prepare a written report, endorsed by the Installer, listing dimensional discrepancies and conditions detrimental to the performance of moving walk work.

330.030 INSTALLATION

A. Comply with manufacturer's instructions and recommendations for work during installation.

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B. Set moving walks true to line and level, properly supported, and anchored to building structure. Use established benchmarks, lines, and levels to ensure dimensional coordination of the Work.

C. Adjust installed components for smooth, efficient operation, complying with required tolerances and free of hazardous conditions. Lubricate operating parts, including bearings, tracks, chains, guides, and hardware. Test operating devices, equipment, signals, controls, and safety devices. Install oil drip pan and check to ensure that no oil drips outside of pan.

D. Repair damaged finishes so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.

E. Assembly: Equipment is, as far as possible, to be factory assembled, wired and tested. Site work shall be limited to installation and assembly of parts dismantled at factory for transportation, or otherwise to work not possible at factory.

F. Workmanship: Carry out work in a neat, workmanlike and efficient manner in accordance with specified requirements. Installation shall be performed by skilled personnel, specialized in moving walk installation, who are in the permanent employment of the manufacturer or manufacturer's authorized dealer.

G. Accessibility: Install equipment so that it is readily accessible for operation, maintenance and repair.

H. Builder's Work: Carry out all builder's work necessarily required in connection with the installation of moving walks, including but not limited to forming or cutting chases, rebates, etc., grouting, supports, steelwork, scaffolding, etc. Provide convenience power, lighting and other services required from assigned terminal points, to carry out construction work.

I. Coordination: Coordinate equipment installations with the building construction to prevent alteration to structure and cutting of holes and chases after equipment installation has started.

J. Fire Protection: Coordinate installations with mechanical works, for provision of fire/smoke detection and fire fighting systems.

K. Painting: Protect unfinished metalwork by painting, unless technically undesirable. Painting shall include thorough cleaning of metal, application of rust inhibiting prime coat and two finishing coats of approved enamel.

330.040 FIELD QUALITY CONTROL

A. Tests: After installation is complete and prior to Substantial Completion, carry out all tests required by the Governing Regulations and Standards (refer to EN 115-1 requirements). Carry out any other tests the Engineer may require to check safety and compliance of installation with specified requirements. Tests shall be witnessed by the Engineer and, if required, by the authorities having jurisdiction.

B. Equipment Failure: Repair and make good any damage to equipment caused by tests, or damage to building caused by failure of any part of the installation, to the satisfaction of the Engineer.

C. Organization of Tests: Provide all labour, materials and instruments required for tests.

D. Before test run, ensure that step bands, skirtings and comb segments are in order, no foreign bodies are in or on moving walk, all steps are fitted, main circuit breaker is in closed position, control switch is in on position, safety devices and protective switches are in operation, series of safety contacts are closed and manual control device is connected to inspection run power socket.

E. Test run shall include checking starting from installed service panel, reversing direction of running from manual control device and checking that actual running direction corresponds with direction setting, allowing running in each direction for several cycles. Any adjustments shall be made with inspection control device connected.

F. Testing Operation of Safeties: In accordance with manufacturer's service and maintenance instructions, check all alarms and indicators and lubricating oil system against manufacturer's data.

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G. After testing, check, and if necessary, re-adjust spring tensions on return shaft, handrail pretension, drive rollers, step inlet and outlet, sag, skirtings, gaps etc., brake stopping distance, and gear oil level.

H. Measurements: Measure motor current in both directions of moving walk, and insulation resistance to truss or earth of motor circuit, control circuits, brake circuit, lighting circuits, pump circuit and any other circuits. Insulation resistance shall not be less than 20 M-ohms using a minimum 1000 V d.c. megger.

I. Acceptance Testing: Upon nominal completion of each moving walk installation, and before permitting the use of moving walks (either temporary or permanent), perform acceptance tests as required and recommended by the "Code" and by governing regulations or agencies.

330.050 DEMONSTRATION AND TRAINING

A. Train Employer's maintenance personnel on procedures and schedules for maintaining, operating, adjusting, troubleshooting, and servicing moving walks. Refer to Division A Sections related to Demonstration and Training.

1. Make a final check of each moving walk operation, with Employer's maintenance personnel present, just prior to Substantial Completion. Determine that control systems, operation components and devices are functioning properly.

330.060 PROTECTION

A. At completion of moving walk work, provide suitable protective coverings, barriers, devices, signs, or such other methods or procedures to protect moving walk work from damage or deterioration. Maintain protective measures throughout remainder of construction period.

330.070 MOVING WALK SCHEDULE

A. The Contractor shall coordinate the final space requirements (truss depth, pit depth, overall length, etc.) with the architectural layout and details. Ensure full compatibility. Any contradiction shall be raised to the Engineer.

B. Moving Walk No :

1. Length: …….. m.
2. Overall Width: ……m.
3. Inclination of Ramp: …….degrees.
4. Width of Pallet: …… m.
5. Speed: ……..m/sec.
6. Pit Dimensions (at each side):

a) Length: …….. m.
b) Width: ……. m.
c) Depth: ……m.

7. Intermediate Pit Depth: …….. m.

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X20 - HOISTS

PART 3 SPECIFICATION CLAUSES SPECIFIC TO X20

300.000 GENERAL

300.010 COMPLIANCE WITH LEGISLATION:

- Ensure the installation, commissioning and setting to work of the hoists complies with the general requirements of the Health and Safety at Work etc. Act 1974 and where appropriate,
    - The Factories Act 1961.
    - The Lifting Operations and Lifting Equipment Regulations 1998.

300.020 HOIST SPECIALIST:

- Engage a specialist to supply, install and commission the hoist installation.

310.000 PRODUCTS/MATERIALS

310.010 DOMESTIC PERSONNEL LIFT OR HOIST:

- Manufacturer and reference
    - Style
    - Stair lift.
    - Powered domestic lift.
    - Manual home lift.
    - Platform hoist.
- Standard
    - BS 5900.
    - BS 5965.
    - BS 6440.
    - BS EN 81-40.
- Operation
    - Dedicated user.
    - General use.
    - For use by disabled person.
- Position of users
    - Sitting.
    - Standing.
    - Seated in wheelchair.
- Location
    - Indoors.
    - Outdoors.
    - Domestic.
    - Non-domestic.

- Controls
    - Left handed use.
    - Right handed use.
    - Duplicate controls.
    - Attendant controls.
    - On/off key switch.
- Ancillaries
    - Automatic car doors.
    - Automatic car barriers or gates.
    - Manual car doors.
    - Manual car barriers or gates.
    - Seats.
    - Handrail.
    - Wheelchair stops.
    - Alarm system to
        - BS EN 50134-1 - System requirements.
        - BS EN 50134-2 - Trigger devices.
        - BS EN 50134-3 - Local unit and controller
        - DD CLC/TS 50134-7 - Application guidelines.
    - Emergency lighting.
    - Landing doors or gates.
    -
- Drive type
    - Electric, rack and pinion.
    - Electric, screw and nut.
    - Direct hydraulic to BS ISO 4413.
    - Direct pneumatic to BS ISO 4414.
    - Suspended, electric.
    - Suspended, electro-hydraulic.
    - Manual operation.
- Liftway protection
    - Intermediate landing.
    - Upper landing.
    - Lower landing.
    - Total enclosure.
    - Access to platform to BS 8300-1 and BS 8300-2.
    - Method of door or barrier operation
    - Door or barrier locking

310.030 VEHICLE LIFTS:

- Standards
    - BS EN 1493 and BS 7980.
- Lift Type

    - Wheel supporting.
    - Axle supporting.
    - Frame supporting.
    - Single ram.
    - Multi-ram.
    - Single post.
    - Two post.
    - Four post.
    - Multi-post.
    - Drive through.
    - Drive on - back off.
    - Balcony.
- Drive Type
    - Fully hydraulic.
    - Semi-hydraulic.
    - Mechanical, rope and winch.
    - Mechanical, chain drive.
    - Mechanical, rack and pinion.
    - Mechanical, screw and nut.
    - Mechanical
    - Electrical powered.
    - Manually operated.
    - Combined drive.
- Controls
    - Manual dead-mans' type.
    - Foot.
    - Lever.
    - Stop.
    - Raise.
    - Lower.
    - Extend.
    - Rotate.
    - Emergency stop
- Safety devices
    - Mechanism guarding
    - Enclosure degree of protection to BS EN 60529
    - Trip bars.
    - Scotching device.
    - Overnight brake.
    - Automatic chocks.
    - Hand chocks.
    - Hinged ramps.
    - Handrails and toe boards.
    - Access gates.
    - Synchronised multiple lifts.
    - Overbalanced axle or chassis supports.
    - Non-overbalanced axle or chassis supports.
    - Warning notices.

- Platform arrangement
    - Platform surface.
    - Lifting pads.
    - Balcony construction.
- Location
    - Indoors.
    - Outdoors.
    - Surface-mounted.
    - Flush-mounted.
    - Recessed.
- Ancillaries
    - Wheel free supports.
    - Wheel free auxiliary lifts.
    - Scissor action jacking beam.
    - Radius plates.
    - Lighting.

310.040 HOISTS:

- Manufacturer and reference Materials and equipment shall be standard products of manufactures regularly engaged in the fabrication, Sales and Service of hoists.
- Or approved equivalent
- Safety requirements for non-fixed load lifting attachments to BS EN 13155.
- Standard
    - Applicable Local Building Laws as far as congruent with the stated EN codes and standards.
    - Local Codes, Ordinances and Laws as far as congruent with the stated EN codes
    - and standards.
    - 2006 / 42 EC European Machinery Directive.
    - 2006 / 95 EC European Directive relating to electrical equipment designed for use
    - within certain voltage limits.
    - 2004 / 108 EC European Directive relating to Electromagnetic Compatibility
    - EN ISO 12100 Safety of machinery – General principles for design – Risk assessment and risk reduction.
    - EN ISO 13850 Safety of machinery: Emergency stop - Principles for design.
    - EN ISO 13857 Safety of machinery: Safety distances to pre-vent danger zones being reached by upper and lower limbs.
    - EN ISO 13849-1/2 Safety of machinery - Safety related parts of control system.
    - EN ISO 14122-1/2/3/4 Safety of machinery: Permanent means of access to machinery.
    - EN 60204 - 1 / 32 Safety of machinery - Electrical equipment of machines.
    - EN ISO 14118 Safety of machinery: Prevention of unexpected start-up.
    - EN 1090-2 Execution of steel structures and aluminium structures.
    - EN 1993-3 Euro code 1: Actions on structure.
    - EN 1993-1-1 / 6 Eurocode 3: Design of Steel structures.
    - EN 13001-1 / 2 / 3-1 Crane safety – General design.
    - EN 15011 Cranes – Bridge and gantry cranes
    - FEM 1.001 Rules for the design of hoisting appliances

- Applicable requirements of the following sections of this specification apply to all work required under this section.
    - 1. Conditions of the Contract.
    - 2. Division 1-General Requirements of the Contract.

- Hoist Type
    - Pallet lifter.
    - Loading platform.
    - Cellar hoist.
    - Car parking hoist.
    - Cantilevered platform.
    - Fixed.
    - Mobile.
    - Installed to crane.
    - Self-propelled.
    - Mobile elevating work platform (MEWP) to BS EN 280.
- Drive type
    - Hydraulic rated as BS ISO 4409.
    - Hydraulic as relevant parts of BS EN 1570.
    - Pneumatic to BS ISO 4414
    - Rack and pinion to ISO 1328-1 and ISO 1328-2
    - Screw and nut
    - Chain drives to BS ISO 1275.
    - Power operated.
    - Manually operated to BS 5655-14.
- Characteristics
    - Safe working load , the hoist shall be equipped with an electro-mechanical load limiting device that shall prevent lifting more than 110% of the rated load.
    - Lifting speed [shall be two-speed/two winding squirrel cage type with a speed that should be in range of low speed 1-3 m/min and high speed 4-8 m/min.....]
    - Noise level
    - Hoisting motor(s) shall be totally enclosed fan cooled with IP55 protection, minimum class B insulation, bimetal switch for thermal protection and shall have a 60% ED rating.
    - Hoist motor brake shall be DC disc type with adequate torque to stop and hold over 125% of the hoist rated load.
    - Wire rope shall be constructed from galvanized steel having a minimum safety factor of 5.
    - Trolley shall be furnished with an adjustable frequency inverter drive and two step or infinitely variable speed control for smooth acceleration and deceleration.
    - Trolley motors shall be inverter duty motors with minimum class "F" insulation and motor enclosures shall be - TEFC [totally enclosed fan cooled].
    - Rotary cam type limit switch equipped with 4 micro-switches shall be provided.
    - Limit switch shall provide upper and lower limit of hoist travel, hoist slow down prior to reaching upper limit and phase sequence supervision at upper limit. An additional block operated limit shall be included.
    - Large diameter rope drum with a minimum of 18:1 drum to wire rope diameter ratio. Groove depth shall be at least 35% of rope diameter. The rope drum shall be equipped with a rope guide to help keep the rope aligned in the grooves of the drum.
    - Hoist reeving shall be single reeved. Lateral hook drift shall not exceed 3 mm per 300 mm of vertical travel on single reeved models.

- The actual hoist control enclosure rating shall be at least equivalent to IP55 / 4 type.
- Hooks shall be made of forged alloy steel (34CrMo4QT or 34CrNiMo6QT or equivalent) and shall be fitted with a spring-loaded flipper-type safety latch.
- Hoist shall have a duty rating suitable for the load class and load cycles of the EN 13001, as applicable, for Crane Class HC2 S3 FEM 9,511 group 2m.
- Bridge drive gearing, according to European Standards.
- Trolleys shall have safety drop lugs and energy absorbing bumpers, calculated according to EN 13001 with reduced speed.

- Controls
  - Automatic.
  - Automatic levelling.
  - Manual, dead-mans' type.
  - Foot.
  - Lever.
  - Wander lead.
  - Duplicate controls.
  - Stop.
  - Call.
  - Raise.
  - Lower.
  - Indexing.
  - Emergency stop.
  - Photo electric cell limit switches.
  - Hoist shall be 2 speed magnetic reversing type.
  - Six-way operation, pushbutton pendant suspended from hoist carrier or crane. Radio control may be quoted as an option.
  - Electrical control enclosures shall be IP55 Pushbutton enclosure shall have a rating of IP65.
- Safety devices
  - Mechanism guarding.
  - Enclosure degree of protection to BS EN 60529
  - Trip bars.
  - Sensitive edges.
  - Sensitive surfaces.
  - Re-set control.
  - Scotching device.
  - Inspection hatch.
  - Safety load flaps or stops.
  - Automatic safety load flaps or stops.
  - Handrails.
  - Toe boards.
  - Gates.
  - Synchronising of multiple drives.
  - Phase failure device.
  - Phase reversal device.
  - Warning device Horn and Light.
- Location
  - Indoors.
  - Outdoors.

- Installed into pit.
- Installed into dock.

- Platform arrangement
  - Lifting table.
  - Platform surface.
  - Working platform.
  - Goods lift.
  - Lorry loader.
  - Handling system.

- Ancillaries
  - Wheels.
  - Castors.
  - Lift forks.
  - Fork lift channels.
  - Turntable.
  - Roller conveyor top.
  - Loading ramps.

320.000 WORKMANSHIP

320.010 WORK ON-SITE:

- Ensure that all structural and building works are carried out and that service connections are provided,

320.015 SUBMITTALS:

- General: Submit the following according to Conditions of Contract and Division 1 Specification Sections.
- Product data including rated capacities and duties of selected models, weights (shipping, installed, and operating), furnished specialties, and accessories. Indicate dimensions, required clearances, methods of assembly of components and wiring connections. Include the following
- Wiring diagrams for each item of equipment with electric power supply. Include ladder-type wiring diagrams for interlock and control wiring required for final installation. Differentiate between portions of wiring that are factory-installed and field-installed

- Maintenance data for inclusion in Operating and Maintenance Manuals as specified in Division A

320.020 QUALITY CONTROL:

- Handle, store and install all equipment and components of the hoist in accordance with the manufacturer's recommendations and,
  - BS 5900.
  - BS 6440.
  - BS 7980.
  - BS EN 1493.

- Relevant parts of BS EN 1570.
- BS EN 81-40.

- Inspect all equipment and components on delivery, before fixing and after installation and reject and replace any which are defective.
- Record all commissioning measurements and tests.
- Provide listing/approval stamp, label, or other marking on equipment made to specified standards
- Listing and Labeling: Provide equipment and accessories that are listed and labeled.

320.030 INSTALLATION OF DISABLED PERSONS PLATFORM:

- Install, commission and set to work disabled persons' platform lift in accordance with BS 6440, BS EN 81-40 and manufacturer's recommendations. Provide test and examination certificate and instruct user in its operation.

320.050 INSTALLATION OF VEHICLE LIFTS:

- Install, commission and set to work vehicle lifts to BS EN 1493 and the manufacturer's recommendations. Provide test and examination certification for vehicle lifts.

320.060 INSTALLATION OF HOISTS:

- Install, commission and set to work hoists in accordance with the manufacturer's recommendations. Provide test and examination certification for hoists.

320.070 INSTALLATION OF DOCK EQUIPMENT:

- Install, commission and set to work dock equipment in accordance with the manufacturer's recommendations.

X21 - CRANES

PART 3 SPECIFICATION CLAUSES SPECIFIC TO X21

300.000 GENERAL

300.010 CRANE SPECIALIST:

- Engage a specialist to carry out all aspects of crane installation.

300.020 COMPLIANCE WITH LEGISLATION:

Ensure the design installation, commissioning and setting to work of the crane complies with the general requirements of the local authorities having jurisdiction

310.000 PRODUCTS/MATERIALS

310.010 CRANE INSTALLATION:

- Standard - Supply, install, commission and set to work crane in accordance with
  - BS 5744
  - BS 7121
  - BS EN 12999
  - BS EN 13001
  - BS EN 13135
  - BS EN 14492
  - BS ISO 12448-1
  - BS ISO 16881-1
  - 2006 / 42 EC European Machinery Directive.
  - 2006 / 95 EC European Directive relating to electrical equipment designed for use
  - within certain voltage limits.
  - 2004 / 108 EC European Directive relating to Electromagnetic Compatibility
  - EN ISO 12100 Safety of machinery – General principles for design – Risk assessment and risk reduction.
  - EN ISO 13850 Safety of machinery: Emergency stop - Principles for design.
  - EN ISO 13857 Safety of machinery: Safety distances to pre-vent danger zones being reached by upper and lower limbs.
  - EN ISO 13849-1/2 Safety of machinery - Safety related parts of control system.
  - EN ISO 14122-1/2/3/4 Safety of machinery: Permanent means of access to machinery.
  - EN 60204 - 1 / 32 Safety of machinery - Electrical equipment of machines.
  - EN ISO 14118 Safety of machinery: Prevention of unexpected start-up.
  - EN 1090-2 Execution of steel structures and aluminium structures.
  - EN 1993-3 Euro code 1: Actions on structure.
  - EN 1993-1-1 / 6 Eurocode 3: Design of Steel structures.
  - EN 13001-1 / 2 / 3-1 Crane safety – General design.
  - EN 15011 Cranes – Bridge and gantry cranes
  - FEM 1.001 Rules for the design of hoisting appliances
  - Applicable requirements of the following sections of this specification apply to all work required under this section.
    - 1. Conditions of the Contract.

- 2. Division 1-General Requirements of the Contract.

- FEM - European Federation of Materials Handling and Storage Equipment
- Applicable Local Building Laws as far as congruent with the stated EN codes and standards.
- Local Codes, Ordinances and Laws as far as congruent with the stated EN codes and standards.

- Location
  - Indoors or outdoors as indicated on drawings.
- Special service conditions
  - Crane servicing platforms used for other purposes
  - Fine mesh screens under service platforms.
  - Wind loading as BS EN 1991-1-4
- Load characteristics
  - As per design requirements.
- Crane dimensions
  - As per design requirements
- Type of crane
  - Overhead travelling crane - see clause 310.020
  - Jib crane - see clause 310.030
  - Manual overhead travelling hoist - see clause 310.040
  - Light crane - see clause 310.050
  - Pillar crane - see clause 310.060
  - Cranes - see clause 310.070
- Crane details
  - Crane construction - see clause 310.080
  - Foundations - see clause 310.090
- Installation components
  - Power supply - see clause 310.100
  - Lifting attachments - see clause 310.110
  - Controls - see clause 310.120
  - Control equipment and parameters - see clause 310.130
  - Ancillaries - see clause 310.140
  - Slings - see clause 310.150
  - Ropes and chains - see clause 310.160
  - Crane rails - see clause 310.170

310.020 OVERHEAD TRAVELLING CRANES:

- Standard - BS EN 13001.
- Crane Type
  - Power driven.
  - Overhead travelling.
  - Semi-goliath.
  - Goliath.

- Two trolleys on same bridge or gantry.
- Two point lifting
- Four point lifting
- Offset crab
- Trackless goliath or portal.
- Steerable gantry wheels
- Air supported
- Underslung trolley.
- Top running trolley,
- Single girder.
- Double girder.
- Box girder.
- Cantilevered extension
- Top running bridge carriage
- Underslung bridge carriage
- Travel wheel type
- Traverse wheel type

310.030 JIB CRANES:

- Standard - BS EN 13001 and BS ISO 12488-4.
  -
- Standard - BS ISO 10245-4.
- Mounting
  - On a high pedestal.
  - On portal carriage.
  -
- Jib Construction
  - Strut
  - Cantilever
  - Telescopic
  - Open lattice
  - Plate box
  - Jib extension
  - Hydraulic drive
  - Pneumatic drive
  - Rope drive

310.040 MANUAL OVERHEAD TRAVELLING HOISTS:

- Manufacturer and reference
  - Standard - BS EN 13001.
- Hoist Type
  - Underslung, single girder
  - Top running, single girder
- Characteristics

- Construction of main girder
- Trolley weight
- Crane weight
- Travel wheel loads
- Travel wheel type
- Traverse wheel type
- Chain pulley blocks to BS EN 13157
- Chain lever hoists to BS EN 13157
- Chain drives

310.050 LIGHT CRANES:

- Manufacturer and reference
  - Or approved equivalent
  - Standard - BS EN 13001.
- Crane Type
  - BS 5744 Figure 11 a.
  - BS 5744 Figure 11 b.
  - BS 5744 Figure 11 c.
  - BS 5744 Figure 11 d.
  - Runway beam to BS 2853 without hoist.
  - Runway beam to BS 2853 and hoist
- Characteristics
  - Construction of gantry
  - Gantry height adjustment
  - Construction of main girder or beam
  - Grab weight
  - Crane weight
  - Travel driven wheel loads
  - Travel trailing wheel loads
  - Wheel types
  - Additional safety features
  - Electric chain hoist
  - Chain pulley blocks to BS EN 13157
  - Chain lever hoists to BS EN 13157
  - Chain drives
  - Loose chain box
  - Trolley frame construction
  - Castors
  - Slewing mechanism

310.060 PILLAR CRANES:

- Manufacturer and reference
  - Standard - BS EN 13001.
- Style

- Fixed jib.
- Slewing jib.
- Wall-mounted.
- Overbraced.
- Underbraced.
- Self supporting.
- Twin arm.
- Articulated jib
- Luffing jib
-

- Characteristics
  - Chain pulley block to BS EN 13157

310.070 CRANES:

- Manufacturer and reference
  - Standard - BS EN 13001.
- Style
  - Monorail
  - Radius
  - Diametrical

310.080 CRANE CONSTRUCTION:

- Standard - BS EN 13001.
- Handling molten metal.
- Potentially explosive atmosphere
- Weather protection
- Parking brake, long travel
- Storm anchors
- Parking brake, traversing
- Vertical deflection
- Vibration of structure
- Corrosion allowance
- Exposure to accidental damage
- Enclosed sections
- Strength of joints
- Rail included in effective section
- Effect of wheel loads
- Braced and lattice girders, local bending movements
- Braced and lattice girders, tension members
- Braced and lattice girders, compression member
- Braced and lattice girders, flat lattice bars
- End carriage length
- End carriage wheel base
- Withdrawal of track wheels
- Traverse buffers
- Long travel buffers

- Anti-collision devices
- Traverse end stops
- Drop stops
- Guard rails and toe boards
- Opening in platforms and walkways
- Walkway surfaces
- Ladders
- Stairs
- Emergency escape provision
- Drivers cabin
- Cabin access
- Cabin enclosure
- Cabin lighting
- Audible warning device
- Wheel lateral location
- Wheel construction
- Distribution of tensile forces in ropes
- Rope drum width
- Rope drum capacity
- Rope reeling
- Rope drum flanges
- Rope anchorages
- Rope drum surfaces
- Rope drum grooves
- Rope pulley surfaces
- Rope pulley grooves
- Rope, angle of fleet
- Rope pulley guards
- Brakes generally
- Hoist brakes
- Long travel motion brakes
- Traverse motion brakes
- Slewing brakes
- Luffing brakes
- Other motion brakes
- Gearbox lubrication
- Change-gear levers
- Gearbox inspection covers
- Lubrication of bearings
- Keys and keyways to BS 4235.
- Splines and serrations to BS 2059.
- Guard design to BS EN ISO 12100.
- Inspection covers
- Gear wheel, pinions and chain drive guarding
- Revolving shafts and couplings, guarding
- Hook block guarding
- Provide isolation during repair and maintenance work in accordance with BS EN 62626-1
- Design electrical system in accordance with BS EN 13135
- Select motor using BS EN 13135.
- Power supply isolator
- Main contactor

- Control voltage
- Control circuitry earthing
- Contactors to BS EN 60947-4-1.
- Interlocking of reversing contractors.
- Control circuit transformer to BS EN 61558-1.
- Inter-winding screen
- Control circuit fusing
- Power loss reset
- Control interlocking
- Shrouded push buttons
- Control marking
- Control pendant support
- Non-conductive control security
- Resistor rating to BS EN 60947-4-1
- Maximum motor speed
- Motor pull-out torque
- Enclosure degree of protection to BS EN 60529
- Motor enclosure degree of protection to BS EN 60529
- Interlocking of enclosure access
- Magnet and thruster brake motor ratings
- Minimum brake operating voltage
- Diversion of de-energised motor energy
- Auxiliary equipment operating voltage
- Radio interference suppression to BS EN 55012 and relevant parts of BS EN 55014 + A2.
- Protection of cables
- Cable conductor type
- Minimum conductor size
- Cable rating
- Marking of safe working load

310.090 FOUNDATIONS:

- Ballast
- Fixing down bolts
- Cast in steel work

310.100 POWER SUPPLY:

- Standard
- Provide crane with control, protection and safety equipment in accordance with BS 7671 (the IET Wiring Regulations).

310.110 LIFTING ATTACHMENTS:

- Attachment
    - Hook, to BS EN 1677-5.
    - Hook, to BS EN 1677-5 with safety latch.
    - Liverpool hook.
    - Pole lifts.

- Lifting plate clamps to BS EN 13155.
- Balanced C hook to BS EN 13155.
- Timber dogs.
- Hook rotation locking device.
- Shackles to BS EN 1677-5.
- Lifting beam to BS EN 13155.
- Adjustable lifting beam to BS EN 13155.
- Roll-over beam.
- Lifting spreader.
- Pallet forks.
- Magnet lifting device to BS EN 13155.
- Vacuum lifting device to BS EN 13155.
- Grab.
- Bucket.
- Manipulator.
- Balancer.
- Balancer with float capability.
- Non-fixed load lifting attachment to BS EN 13155.
- Safe working load of lifting attachment

310.120 CONTROLS:

- Standard
- Provide crane control system in accordance with BS 7671 (the IET Wiring Regulations) and the appropriate British Standards.
- Provide crane control system and control station in accordance with BS EN 13557.
- Location and type of controls
    - Panel on crane.
    - Remote panel.
    - Cabin.
    - Pendant.
    - Non - conductive.
    - On lifting attachment.
    - Operator controlled.
    - Automatic.
- Operator controls
    - Push buttons.
    - Levers.
    - Joy stick.
    - Rotary controls.
    - Twist grips.
    - Separate control for each motion direction.
    - Two position single control for each motion direction.
    - Hoist
    - Travel
    - Slew
    - Luff
    - Lifting attachment
    - Other motion

- Stop
- Emergency stop
- Six-way operation, pushbutton pendant suspended from hoist carrier or crane. Radio control may be quoted as an option.

- Cabin
  - On crab.
  - On bridge.
  - At end span.
  - At mid span.
  - Open.
  - Glazed
- Pendant
  - From fixed point on bridge.
  - From crab.
  - Mobile on separate track.
- Non-conductive
  - Infrared
  - Radio
  - Range limitation
  - Warning device in crane

310.130 CONTROL EQUIPMENT AND PARAMETERS:

- Limiting and indicating equipment
  - Standard - BS EN 12077-2.
- Control equipment for
  - main hoist.
  - auxiliary hoist.
  - long travel motion.
  - traverse motion.
  - slewing motion.
  - luffing motion.

310.140 ANCILLARIES:

- Access and Platforms
  - Bridge platforms
  - Trolley platforms
  - Access points
  - Emergency escape devices
- Accessories
  - Light fittings on bridge.
  - Light fittings on crab.
  - Portable lighting.

- Portable tool power sockets.
- Cabin heating.
- Cabin air conditioning.
- Rail clamps.

310.150 ROPES AND CHAINS:

- Select ropes in accordance with BS ISO 16625.
- Ropes and chains for
  - main hoist.
  - auxiliary hoist.
  - traverse motion.
  - travel motion.
  - slewing motion.
  - luffing motion.
  - guy.
  - other motion.
- Type of rope or chain
  - Standard
    - BS ISO 16625
    - BS EN 12385-1.
    - BS EN 12385-2.
    - BS EN 12385-4.
    - BS EN 12385-5.
- Guy anchorages
  - Radii of guy rope anchorages
  - Special anchors

310.160 SLINGS:

- Standard
  - Provide slings and other lifting attachments for use with cranes to BS EN 13001.
    - BS EN 13414-1.
    - BS EN 1492
    - BS ISO 1834.
- Style
  - Two legged.
  - Three legged.
  - Four legged.
  - Collar chain.
  - Endless.
  - Pole lift
  - Lifting plate clamps
  - Hooks to BS EN 1677-5.
  - Hooks

    - Sling ring or eye
- Ropes and chains
- Fittings
    - Master link or ring
    - Chain shortening clutches
    - Auxiliary links or rings
    - Reeving thimbles
    - Hooks
    - Safety latches
    - Hook swivels
    - Shackles
    - Soft eyes

310.170 CRANE RAILS:

- Standard
    - BS ISO 16881-1.
- Rail material and shape
    - BS 4 and BS EN 10034
    - BS EN 10210
    - BS EN 13674
    - BS EN 13674-1
    - BS EN 13674-4
- Rail loading
    - BS EN 1993
    - BS EN 13001
    - BS EN 1090
    - BS EN 1994
    - BS EN 1991
    - Top running crane.
    - Under slung crane.
- Rail fixing
    - Proprietary chairs.
    - Welded to structure.
    - Fixed to structure.
    - Concreted in.
    - [.....]
- Rail installation
    - Track tolerance to BS 466.
- Rail fittings
    - Fish plate joints.
    - Allowance for expansion.
    - Rail end stops.
    - Rail section stops.

- Buffers.
- Resilient buffers to BS EN 13001.
- Rail switches.
- Rail bonding and earthing to BS 5744.

310.180 CURRENT COLLECTION SYSTEM:

- Conductor material
  - Copper.
  - Hard drawn copper.
  - Cadmium copper.
  - Aluminium.
  - Mild steel.
- Conductor shape and size
  - BS EN 50149
- Conductor arrangement
  - Individually shrouded.
  - Common shroud.
  - Bare or unshrouded.
  - Guarding.
  - Number of poles
  - Flat horizontal, spacing
  - Flat vertical, spacing
  - Power track.
  - Enclosure degree of protection to BS EN 60529
  -
- Conductor mounting
- Conductor installation dimensions
- Collector

320.000 WORKMANSHIP

320.010 WORK ON-SITE:

- Ensure that all structural, building and civil engineering works are carried out and that service connections are provided,
- by others

320.015 SUBMITTALS:

- General: Submit the following according to Conditions of Contract and Division 1 Specification Sections.
- Product data including rated capacities and duties of selected models, weights (shipping, installed, and operating), furnished specialties, and accessories. Indicate dimensions, required clearances, methods of assembly of components and wiring connections. Include the following

- Wiring diagrams for each item of equipment with electric power supply. Include ladder-type wiring diagrams for interlock and control wiring required for final installation. Differentiate between portions of wiring that are factory-installed and field-installed

- Maintenance data for inclusion in Operating and Maintenance Manuals as specified in Division A

320.020 QUALITY CONTROL:

- Handle, store and install all equipment and components of the crane in accordance with the manufacturer's recommendations, BS 5744 and BS 7121. Obtain all components for the crane system from approved sources. Inspect all equipment and components on delivery, before fixing and after installation; reject and replace any which are defective. Record all commissioning measurements and tests.
- Provide listing/approval stamp, label, or other marking on equipment made to specified standards
- Listing and Labeling: Provide equipment and accessories that are listed and labeled.

320.030 INSTALLATION OF CRANE:

- Install, commission and set to work the crane in accordance with the appropriate legislation, BS 5744, BS 7121 and manufacturer's recommendations. Provide test certificates as required by legislation and appropriate British Standards.
- requirements of the users insurers

320.040 CERTIFICATION:

- Ensure that tests for certification purposes are witnessed by all parties concerned.
- Witnesses
    - Installers insurers.
    - Contract supervisor.
    - Purchaser.
    - Purchasers insurers.
    - User.
    - Users insurers.

320.050 INSTALLATION OF CRANE RAILS:

- Install crane rails in accordance with the crane supplier's recommendations and,
    - BS EN 1991
    - BS EN 1993
    - BS EN 1994
    - BS EN 13001.
    - BS EN 1090

320.060 INSTALLATION OF COLLECTOR SYSTEM:

- Install, commission and set to work the collector system in accordance with the recommendations of the crane supplier and the collector system manufacturer.

- Current collection system conductors.
- Current collectors.

320.070 TESTING:

- Carry out all tests required under the legislation, under the direction of a Competent Person as detailed in,
- BS 5744.
- BS 7121.

Y10 - PIPELINES AND PIPEWORK

2000 PRODUCTS/MATERIALS PIPELINES

2010A HEAVY BLACK STEEL PIPES TO BS EN 10255:

- Material - Steel
- Standard - BS EN 10255
- Dimensions - Heavy. Random single lengths, 4m to 7m.
- Ends - Screwed to relevant parts of BS EN 10226, taper thread or plain.
- Finish - Varnished.

2010B MEDIUM BLACK STEEL PIPES TO BS EN 10255:

- Material - Steel
- Standard - BS EN 10255
- Dimensions - Medium. Random single lengths, 4m to 7m.
- Ends - Screwed to relevant parts of BS EN 10226, taper thread or plain.
- Finish - Varnished.

2010C MEDIUM GALVANISED STEEL PIPES TO BS EN 10255:

- Material - Steel
- Standard - BS EN 10255.
- Dimensions - Medium. Random single lengths, 4m to 7m.
- Ends - Screwed to relevant parts of BS EN 10226 taper thread.
- Finish - Galvanised to BS EN 10240.

2010D HEAVY GALVANISED STEEL PIPES TO BS EN 10255:

- Material - Steel
- Standard - BS EN 10255.
- Dimensions - Heavy. Random single lengths, 4m to 7m.
- Ends - Screwed to relevant parts of BS EN 10226, taper thread.
- Finish - Galvanised to BS EN 10240.

2010E HEAVY BLACK STEEL PIPES TO BS EN 10255 - GROOVED ENDS:

- Material - Steel
- Standard - BS EN 10255
- Dimensions - Heavy. Random single lengths, 4m to 7m.
- Ends - Grooved for mechanical joints.
- Finish - Unvarnished, varnished, painted.

2010F MEDIUM BLACK STEEL PIPES TO BS EN 10255 - GROOVED ENDS:

- Material - Steel
- Standard - BS EN 10255
- Dimensions - Medium. Random single lengths, 4m to 7m.
- Ends - Grooved for mechanical joints.
- Finish - Unvarnished, varnished, painted.

2010G HEAVY GALVANISED STEEL PIPES TO BS EN 10255 - GROOVED ENDS:

- Material - Steel
- Standard - BS EN 10255.
- Dimensions - Heavy. Random single lengths, 4m to 7m.
- Ends - Grooved for mechanical joints.
- Finish - Galvanised to BS EN 10240.

2010H MEDIUM GALVANISED STEEL PIPES TO BS EN 10255 - GROOVED ENDS:

- Material - Steel
- Standard - BS EN 10255.
- Dimensions - Medium. Random single lengths, 4m to 7m.
- Ends - Grooved for mechanical joints.
- Finish - Galvanised to BS EN 10240.

2030 NON-ALLOY SEAMLESS STEEL TUBES TO BS EN 10216-1:

- Material - non-alloy steel
    - Grade - to suit the application.
- Dimensions
    - BS EN 10220
    - BS EN 10216-1, table 5

2050 WELDED STEEL TUBES TO BS EN 10217-1:

- Dimensions
    - BS EN 10220
    - BS EN 10217-1, table 5

2060A CARBON STEEL FITTINGS, BUTT WELDED TO BS EN 10253:

- Material
    - Carbon steel, grade S235.
- Standard - BS EN 10253-1.
- Size range - 25mm to 400mm.
- Dimensions - BS EN 10253-1.
- Ends - Bevelled.
- Finish - Varnished.

2060B CARBON STEEL FITTINGS, BUTT WELDED TO BS EN 10253:

- Material
    - Carbon steel, grade P235TR2 or P265TR2.
- Standard - BS EN 10253-2. Type B fittings.
- Size range - 25mm to 400mm.
- Dimensions - BS EN 10253-2.

- Ends - Bevelled.
- Finish - Varnished.

2070# MALLEABLE CAST IRON FITTINGS, SCREWED:

- Material - Cast iron to BS EN 1562.
- Standard - BS 143 & 1256 or BS EN 10242.
- Size range - 10mm to 164mm.
- Dimensions - BS 143 & 1256 or BS EN 10242.
- Ends - screwed to relevant parts of BS EN 10226

2080E GALVANISED CAST IRON FITTINGS, GROOVED FOR MECHANICAL JOINTS:

- Material - Steel fittings to ASTM A-536, grade 65-45-12.l
- Standard - Manufacturer's.
- Size range - 20mm to 600mm.
- Ends - Grooved or mechanical joints.
- Finish - Galvanised.

2080F PAINTED STEEL FITTINGS, GROOVED FOR MECHANICAL JOINTS:

- Material - Steel fittings to ASTM A-53.
- Standard - Manufacturer's.
- Size range - 20mm to 600mm.
- Ends - Grooved for mechanical joints.
- Finish - Painted.

2090 STEEL FITTINGS, SCREWED TO BS EN 10241:

- Standard - BS EN 10241.
- Size range - 6mm to 150mm.
- Dimensions - BS EN 10241.
- Ends - Screwed to relevant parts of BS EN 10226.
- Finish
    - Black or galvanized to suit pipework system.

2220 LIGHT GAUGE STAINLESS STEEL TO BS EN 10312:

- For use with push and pressfit piping systems.
- Material - Stainless steel, austenitic grade 316 (1.4401).
- Standard - BS EN 10312.
- Dimensions - BS EN 10312 as per tables 1 and 2.
- Ends - Plain.
- Finish - Uncoated.

2230 AUSTENITIC STAINLESS STEEL TO BS 4825-1:

- Material - austenitic stainless steel.
- Standard

- Dimensions
    - BS 4825-1 table 2.
- Ends - plain.

2231 AUSTENTIC STAINLESS STEEL TO BS EN 10357:

- Material - austenitic stainless steel tube
- Type - welded.
- Dimensions
    - BS EN 10357 tables 1 and 2.
- Ends - plain.

2240 AUSTENITIC STAINLESS STEEL FITTINGS:

- Material
    - Fittings - austenitic steel.
    - Gaskets
        - natural rubber tested to BS ISO 48
        - synthetic rubber tested to BS ISO 48
- Standard BS EN 10357 and BS 4825-1.
- Size range
    - BS 4825-2, 12mm to 219.1mm.
    - BS 4825-3, expanded type 25mm to 76.1mm.
    - BS 4825-3, welded type 25mm to 219.1mm.
    - BS 4825-4, 12mm to 101.6mm.
    - BS 4825-5, expanded type 25mm to 76.1mm.
    - BS 4825-5, welded type 25mm to 101.6mm.
- Dimensions
    - BS 4825-2 - Bends and Tees.
    - BS 4825-3 - Clamp type couplings.
    - BS 4825-4 - Screwed couplings.
    - BS 4825-5 - Recessed ring joint type coupling.
- Ends - Plain.

2250A AUSTENITIC STAINLESS STEEL TO BS EN 10216-5:

- Material - Austenitic stainless steel, seamless.
- Standard - BS EN 10216-5.
- Dimensions - BS EN ISO 1127.
- Ends - Plain.
- Finish - Uncoated.

2250B AUSTENITIC STAINLESS STEEL TO BS EN 10217-1:

- Material - Austenitic stainless steel, welded.

- Standard - BS EN 10217-7.
- Dimensions - BS EN ISO 1127.
- Ends - Plain
- Finish - Uncoated.

2255A STAINLESS STEEL FITTINGS, GROOVED MECHANICAL JOINTS:

- Material - stainless steel grades 304, 316, 316L, 316T, schedules 5S, 10S, 20S, 40S.
- Standard - Manufacturer's.
- Size range - 20mm to 600mm.
- Dimensions - manufacturer's standard.
- Ends - grooved for mechanical joints. Use special 'RX' type roll sets for stainless steel pipe.
- Finish - natural.

2257 STAINLESS STEEL PUSH-FIT FITTINGS

- Material - Stainless steel
- Standard - Manufacturer's standard.
- Size range - 15mm to 54mm.
- Dimensions - to suit stainless steel pipe to BS EN 10216-5 and BS EN 10217-7.
- Ends - push-fit with EPDM O ring.
- Finish - Natural.
- Jointing - Provide manufacturer's recommended tool for releasing push-fit fittings in push-fit jointing systems.

2270# COPPER, HALF HARD:

- Kitemarked.
- Material - copper.
- Standard - BS EN 1057, R250, (Class X).
- Dimensions - BS EN 1057 table 3.
- Ends - plain, grooved for mechanical joints; copper-tube dimensioned.

2280# COPPER, SOFT:

- Material - Copper.
- Standard - BS EN 1057, R220, (Class Y).
- Dimensions - BS EN 1057 table 3.
- Ends - Plain.

2290# COPPER, HARD:

- Material - Copper.
- Standard - BS EN 1057, R290, (Class Z).
- Dimensions - BS EN 1057 table 3.
- Ends - Plain.

2310# CAPILLARY FITTINGS FOR COPPER TUBING:

- Material - Copper or dezincifiable resistant copper alloy.
- Standard - BS EN 1254-1.

- Size range - 6mm to 67mm.
- Dimensions - BS EN 1254-1 table 2.
- Ends - Integral (lead-free) solder ring.

2320# TYPE A COMPRESSION FITTINGS FOR COPPER TUBING:

- Kitemarked.
- Material - Dezincifiable resistant copper alloy
- Standard - BS EN 1254-2, type A, non-manipulative.
- Size range - 6mm to 54mm.
- Dimensions - BS EN 1254-2, table 2 and 3.
- Ends - Socket.

2390# CAST IRON PIPES AND FITTINGS TO BS EN 877:

- Material - Cast iron.
- Standard - BS EN 877.
- Dimensions - BS EN 877, table 1.
- Ends - Plain.

2425A FLANGED DUCTILE IRON PIPES AND FITTINGS TO BS ISO 2531:

- Material - Ductile iron.
- Standard - BS ISO 2531.
- Dimensions - Flanged, table 16.
- Ends - Flanged.
- Finish - External, zinc rich, with polyethylene sleeving, extruded polyethylene, extruded polypropylene or polyurethane to BS EN 15189.
- Internal, high alumina cement mortar.

2425B DUCTILE IRON PIPE AND FITTINGS TO BS ISO 2531:

- Material - Ductile iron.
- Standard - BS ISO 2531.
- Dimensions - Spigot/socket, table 17.
    - Permissible deviation on length of fittings, table 6.
- Ends - Spigot or socket.
- Finish - External, zinc rich, with polyethylene sleeving, extruded polyethylene, extruded polypropylene or polyurethane to BS EN 15189.
- Internal, high alumina cement mortar.

2430 MULTILAYERED PIPING SYSTEM FOR HOT AND COLD WATER TO BS EN ISO 21003:

- Piping system to
    - BS EN ISO 21003-1
    - BS EN ISO 21003-2
    - BS EN ISO 21003-3

- BS EN ISO 21003-5

- Materials - as scheduled or specified in the particular specification.
  - Appropriate standards.
    - Polypropylene (PP)
      - BS EN ISO 15874-1
      - BS EN ISO 15874-2
      - BS EN ISO 15874-3
      - BS EN ISO 15874-5
    - Crosslinked polyethylene (PE-X)
      - BS EN ISO 15875-1
      - BS EN ISO 15875-2
      - BS EN ISO 15875-3
      - BS EN ISO 15875-5
    - Polybutylene (PB)
      - BS EN ISO 15876-1
      - BS EN ISO 15876-2
      - BS EN ISO 15876-3
      - BS EN ISO 15876-5
    - Chlorinated polyvinyl chloride (PVC-C)
      - BS EN ISO 15877-1
      - BS EN ISO 15877-2
      - BS EN ISO 15877-3
      - BS EN ISO 15877-5
    - Polyethylene of raised temperature resistance (PE-RT)
      - BS EN ISO 22391-1
      - BS EN ISO 22391-2
      - BS EN ISO 22391-3
      - BS EN ISO 22391-5
- Installation standard - manufacturer's standard.
- Size range - 16mm to 50mm.
- Dimension - manufacturer's standard.
- Ends - compression.
- Finish - black.

2442 PLASTIC PIPING SYSTEMS TO BS EN 15014:

- Standard - BS EN 15014.
- Application - Buried and above ground systems for water (not potable) and other fluids under pressure.
- Performance characteristics for pipes, fittings and their joints.
- Performance characteristics - reaction to fire; external pressure strength; internal pressure strength; dimensional tolerance; tightness (air and water); durability; dangerous substances.

2455A PLASTICS PIPING SYSTEMS FOR WATER SUPPLY - PIPES TO BS EN ISO 1452:

- Material - Unplasticised polyvinyl chloride (PVC-U).
- Standard - BS EN ISO 1452-2.
- Dimensions - Length - manufacturer's standard range. BS EN ISO1452-2 tables 1, 2, 3, 4 and 5.
- Ends - Plain; elastomeric ring seal socket and spigot; or socket and spigot for solvent cement.
- Finish - Grey, blue or cream.

2475A PLASTICS PIPING SYSTEMS FOR WATER SUPPLY - FITTINGS TO BS EN ISO 1452:

- Plastic piping system for water under pressure up to 45^{o}C and drainage/sewerage under pressure.
- Material - Unplasticised polyvinyl chloride (PVC-U).
- Standard - BS EN ISO 1452-3.
- Size range - 12mm to 315mm (injection moulding fittings); 63mm to 630mm (bends made from pipe)
- Dimensions - BS EN ISO 1452-3.
- Ends - Plain; elastomeric ring seal socket and spigot; or socket and spigot for solvent cement.
- Finish - Grey or brown.

2491A ORIENTED UNPLASTICISED PVC TO BS ISO 16422:

- Material - Unplasticised PVC.
- Standard - BS ISO 16422.
- Dimensions - BS ISO 16422.
- Ends - Plain, socket.
- Finish - Blue, grey or cream.

2495A PLASTICS PIPING SYSTEMS TO BS EN 1453:

- Plastics piping system with structured wall pipes for soil and waste discharge (low and high temperature) within the building structure.
- Material - Unplasticised polyvinyl chloride (PVC-U).
- Standard - BS EN 1453.
- Dimensions - Length - manufacturer's standard range. BS EN 1453 tables1, 2 and 3.
- Ends - Plain; elastomeric ring seal socket and spigot; or socket and spigot for solvent cement.
- Finish - Grey, black, or white.

2500A POLYETHYLENE PIPING SYSTEMS FOR UNDERGROUND DRAINAGE AND SEWERAGE TO BS EN 12666:

- Plastics piping system for underground drainage and sewerage both buried in the ground within the building structure, and buried in the ground outside the building structure.
- Material - polyethylene (PE).
- Standard - BS EN 12666-1.
- Dimensions - Length - manufacturer's standard range.
- Ends - Plain; elastomeric ring seal; or socket and spigot; for butt fused joints, electrofusion joints or mechanical joints.
- Finish - Black, or as agreed between manufacturer and purchaser.

2545A PLASTICS PIPING SYSTEMS TO BS EN 1451-1 - PIPES:

- Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure.
- Material - Polypropylene (PP).
- Standard - BS EN 1451-1 and BS EN 15012.
- Dimensions - Length - manufacturer's standard range. BS EN 1451-1 tables 1, 2, 3 and 4.
- Ends - Plain; elastomeric ring seal socket and spigot; or socket and spigot for solvent cement.
- Finish - Grey, black, or white.

2552A POLYPROPYLENE PIPING SYSTEMS FOR UNDERGROUND DRAINAGE AND SEWERAGE TO BS EN 14758-1:

- Plastics piping system for underground drainage and sewerage both buried in the ground within the building structure, and buried in the ground outside the building structure.
- Material - Polypropylene with mineral modifiers (PP-MD).
- Standard - BS EN 14758-1.
- Dimensions - Length - manufacturer's standard range.
- Ends - Plain (with or without chamfer); or single socket with ring seal (with or without chamfer).
- Finish - Black, orange-brown (approximately RAL 8023) or dusty grey (approximately RAL 7037). Other colours may be used.

2553A PIPES AND FITTINGS WITH SMOOTH INTERNAL AND EXTERNAL SURFACE, TYPE A, TO BS EN 13476-2:

- Standards - BS EN 13476-1 and BS EN 13476-2.
- Dimensions - BS EN 13476-2, Section 7.
- Ends - Spigot, Type A1, Type A2, Type B.
- Finish - Black, orange-brown, dusty grey.

2553B PIPES AND FITTINGS WITH SMOOTH INTERNAL AND PROFILED EXTERNAL SURFACE, TYPE B, TO BS EN 13476-3:

- Standards - BS EN 13476-1 and BS EN 13476-3.
- Dimensions - BS EN 13476-3, Section 7.
- Ends - Solid plain, Type A1, Type A2, Type B.
- Finish - Black, orange-brown, dusty grey

2555A PLASTICS PIPING SYSTEMS TO BS EN 1451-1 - FITTINGS:

- Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure.
- Material - Polypropylene (PP).
- Standard - BS EN 1451-1 and BS EN 15012.
- Size range - 32mm to 315mm.
- Dimensions - BS EN 1451-1 tables 5 - 8.
- Ends - Plain; elastomeric ring seal socket and spigot; or socket and spigot for solvent cement.
- Finish - Grey, black, or white.

2580A PVC-U PIPING SYSTEMS - PIPES:

- Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure.
- Material - Unplasticised polyvinyl chloride (PVC-U).
- Standard - PVC-U to BS EN 1329-1
- Dimensions - Length - manufacturer's standard range. BS EN 1329-1 tables 1, 2, 3 and 4.
- Ends - Plain; elastomeric ring seal socket and spigot; or socket and spigot for solvent cement.
- Finish - Grey, black, or white.

2580B ABS PIPING SYSTEMS - PIPES:

- Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure.
- Material - Acrylonitrile-butadiene-styrene (ABS).
- Standard - ABS to BS EN 1455-1.
- Dimensions - Length - manufacturer's standard range. BS EN 1455-1 tables 1, 2, 3 and 4.
- Ends - Plain; elastomeric ring seal socket and spigot; or socket and spigot for solvent cement.
- Finish - Grey, black, or white.

2580C PE PIPING SYSTEMS - PIPES:

- Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure.
- Material - Polyethylene (PE).
- Standard - PE to BS EN 1519-1.
- Dimensions - Length - manufacturer's standard range. BS EN 1519-1 tables 1, 2, 3 and 4.
- Ends - Plain; elastomeric ring seal socket and spigot; or socket and spigot for solvent cement.
- Finish - Grey, black, or white.

2580D SAN AND PVC PIPING SYSTEMS - PIPES:

- Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure.
- Material - Styrene copolymer blends (SAN + PVC).
- Standard - SAN + PVC to BS EN 1565-1.
- Dimensions - Length - manufacturer's standard range. BS EN 1565-1 tables 1, 2, 3 and 4.
- Ends - Plain; elastomeric ring seal socket and spigot; or socket and spigot for solvent cement.
- Finish - Grey, black, or white.

2580E PVC-C PIPING SYSTEMS TO BS EN 1566-1 - PIPES:

- Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure.
- Material - Chlorinated polyvinyl chloride (PVC-C).
- Standard - PVC-C to BS EN 1566-1.
- Dimensions - Length - manufacturer's standard range. BS EN 1566-1 tables 1, 2, 3 and 4.
- Ends - Plain; elastomeric ring seal socket and spigot; or socket and spigot for solvent cement.
- Finish - Grey, black, or white.

2580F STRUCTURED-WALL PVC-U PIPING SYSTEMS - PIPES:

- Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure.
- Material - Unplasticised polyvinyl chloride (PVC-U).
- Standard - Structure-wall PVC-U to BS EN 1453-1.
- Dimensions - manufacturer's standard range. BS EN 1453-1.
- Ends - Plain; elastomeric ring seal socket and spigot; or socket and spigot for solvent cement.
- Finish - Grey.

2585A PVC-U PIPING SYSTEMS TO BS EN 1329-1 - FITTINGS:

- Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure.
- Material - Unplasticised polyvinyl chloride (PVC-U).
- Standard - PVC-U to BS EN 1329-1
- Size range - 32mm to 315mm.
- Dimensions - BS EN 1329-1 tables 5-14.
- Ends - Plain; elastomeric ring seal socket and spigot; or socket and spigot for solvent cement.
- Finish - Grey, black, or white.

2585B ABS PIPING SYSTEMS TO BS EN 1455-1 - FITTINGS:

- Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure.
- Material - Acrylonitrile-butadiene-styrene (ABS).
- Standard - ABS to BS EN 1455-1.
- Dimensions - BS EN 1455-1 tables 5-12.
- Ends - Plain; elastomeric ring seal socket and spigot; or socket and spigot for solvent cement.
- Finish - Grey, black, or white.

2585C PE PIPING SYSTEMS TO BS EN 1519-1 - FITTINGS:

- Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure.
- Material - Polyethylene (PE).
- Standard - PE to BS EN 1519-1.
- Size range - 32mm to 315mm.
- Dimensions - BS EN 1519-1 tables 5-9.
- Ends - Plain; elastomeric ring seal socket and spigot; or socket and spigot for solvent cement.
- Finish - Grey, black, or white.

2585D SAN AND PVC PIPING SYSTEMS TO BS EN 1565-1 - FITTINGS:

- Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure.
- Material - Styrene copolymer blends (SAN + PVC).
- Standard - SAN + PVC to BS EN 1565-1.
- Dimensions - BS EN 1565-1 tables 5-11.
- Ends - Plain; elastomeric ring seal socket and spigot; or socket and spigot for solvent cement.

- Finish - Grey, black, or white.

2585E PVC-C PIPING SYSTEMS TO BS EN 1566-1 - FITTINGS:

- Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure.
- Material - Chlorinated polyvinyl chloride (PVC-C).
- Standard - PVC-C to BS EN 1566-1.
- Dimensions - BS EN 1566-1 tables 5-12.
- Ends - Plain; elastomeric ring seal socket and spigot; or socket and spigot for solvent cement.
- Finish - Grey, black, or white.

2595 PLASTICS PIPING SYSTEMS TO BS EN ISO 15874:

- Plastics piping systems for hot and cold-water installations, including heating, within buildings.
- Material - Polypropylene (PP).
- Standards
    - BS EN ISO 15874-1 - General
    - BS EN ISO 15874-2 - Pipes
    - BS EN ISO 15784-3 - Fittings
    - BS EN ISO 15784-5 - Fitness for purpose of system
- Dimensions - manufacturer's standard range.
- Pipe ends - Plain, socket for fusion fittings, socket for electrofusion fittings, for mechanical fittings or fittings with incorporated inserts.
- Fittings ends - Plain, socket fusion fittings, electrofusion fittings, mechanical fittings or fittings with incorporated fittings

2597 PLASTICS PIPING SYSTEMS TO BS EN ISO 15875:

- Plastics piping systems for hot and cold-water installations, including heating, within buildings.
- Material - Crosslinked polyethylene (PE-X).
- Standards
    - BS EN ISO 15875-1 - General
    - BS EN ISO 15875-2 - Pipes
    - BS EN ISO 15875-3 - Fittings
    - BS EN ISO 15875-5 - Fitness for purpose of the system
- Dimensions - manufacturer's standard range.
- Ends - Plain, suitable for electrofusion fittings, mechanical fittings, or fittings with incorporated inserts.
- Fitting ends - Plain, socket fusion fittings, electrofusion fittings, mechanical fittings or fittings with incorporated fittings
-

2599 PLASTICS PIPING SYSTEMS TO BS EN ISO 15876:

- Plastics piping systems for hot and cold-water systems, including heating, within buildings.
- Material - polybutylene (PB).
- Standards:
    - BS EN ISO 15876-1 - General
    - BS EN ISO 15876-2 - Pipes

    - BS EN ISO 15786-3 - Fittings
    - BS EN ISO 15876-5 - Fitness for purpose of the system
- Dimensions - manufacturer's standard range.
- Ends - Plain, sockets for fusion fittings, suitable for electrofusion fittings, mechanical fittings, or fittings with incorporated inserts.
- Fittings ends - Plain, socket fusion fittings, electrofusion fittings, mechanical fittings or fittings with incorporated fittings.
- Finish - Natural or coloured

2601 PLASTICS PIPING SYSTEMS TO BS EN ISO 15877:

- Plastics piping systems for hot and cold-water installations within buildings.
- Material - chlorinated poly (vinyl chloride) (PVC-C).
- Standards
    - BS EN ISO 15877-1 - General
    - BS EN ISO 15877-2 - Pipes
    - BS EN ISO 15877-3 - Fittings
    - BS EN ISO 15877-5 - Fitness for purpose of the system
- Dimensions - manufacturer's standard range.
- Pipe ends - Plain, single socket.
- Fittings ends - Plain, cylindrical sockets or conical sockets.

2603 PLASTICS PIPING SYSTEMS TO BS EN ISO 22391:

- Plastics piping systems for hot and cold-water installations within buildings.
- Material - Polyethylene of raised temperature resistance (PE-RT).
- Standards
    - BS EN ISO 22391-1 - General
    - BS EN ISO 22391-2 - Pipes
    - BS EN ISO 22391-3 - Fittings
    - BS EN ISO 22391-5 - Fitness for purpose of the system
- Dimensions - Length and wall thickness - manufacturer's standard range.
- Pipe ends - Plain, single socket.
- Fittings ends - Plain, cylindrical sockets or conical sockets

2668# POLYETHYLENE PIPES TO BS EN 12201:

- Plastic piping system for water under pressure up to 20°C and 25bar and drainage/sewerage under pressure.
- Material - Polyethylene.
- Standard - BS EN 12201-1, BS EN 12201-2 and BS EN 12201-5.
- Dimensions
    - BS EN 12201-2, table 2.
- Lengths - No requirements, to be agreed between purchaser and manufacturer.
- Marking – BS EN 12201-2, table 6.
- Ends – Plain or Sockets
- Finish

- Blue or Black with Blue Stripes - water for human consumption.
- Black or black with brown stripes - drainage/sewerage.

2669# POLYETHYLENE FITTINGS TO BS EN 12201:

- Material - Polyethylene.
- Standard - BS EN 12201-3.
- Dimensions - BS EN 12201-3, section 6 and Annex A.
- Marking - BS EN 12201-3, section 11, and table 8.
- Ends - Plain.
- Finish – Blue or Black

2685# UNPLASTICIZED PVC PIPES TO BS EN 1401-1:

- Material - Unplasticized polyvinyl chloride.
- Standard - BS EN 1401-1.
- Dimensions
  - Length - manufacturer's standard range.
  - Mean outside diameter - BS EN 1401-1, Table 3.
  - Wall thickness - BS EN 1401-1, Table 4.
- Ends - Socket and spigot for solvent cement.
- Finish - Dusty grey.

2686# UNPLASTICIZED PVC PIPE FITTINGS TO BS EN 1401-1:

- Material - unplasticized polyvinyl chloride.
- Standard - BS EN 1401-1.
- Size range -110mm to 1000mm (nominal outside dia.).
- Dimensions - BS EN 1401-1, Tables 5 to 8.
- Ends - Solvent cement, socket/spigot.
- Finish - Dusty grey.

2880 PRE-INSULATED BONDED PIPE SYSTEMS FOR DISTRICT COOLING/HEATING - STEEL

- Supply pre-insulated bonded pipe systems for underground networks, designed, installed and tested in accordance with BS EN 13941.
- Single service pipes to comprise, straight lengths of prefabricated thermally insulated pipe-in-pipe assemblies comprising mild steel service pipes, polyurethane thermal insulation and high density polyethylene outer casing to BS EN 253.
- Provide fitting and valve assemblies in accordance with BS EN 448 and. Joint assemblies to be in accordance with BS EN 489
- Installation to be in accordance with the manufacturer's instructions.

3000 PRODUCTS/MATERIALS - JOINTING AND ACCESSORIES

3010A CIRCULAR FLANGES FOR PIPES, PN DESIGNATED - WELDED FLANGE:

- Material - BS EN 1092-1.

- Flange type - Weld neck flange or hubbed slip-on flange for welding.
- Flange facings - Raised face - type B.
- Bolting - In accordance with BS EN 1092-1.

3010C CIRCULAR FLANGES FOR PIPES, PN DESIGNATED - CAST IRON FLANGE:

- Material - BS EN 1092-2 - Ductile cast iron.
- Bolting - In accordance with BS EN 1092-2.

3020A JOINTING RINGS - NON-METALLIC FLAT GASKETS:

- Non-metallic flat gaskets for flanges to BS EN 1092-4.
- Standard - BS EN 1514-1
- Gasket type - Full face for type B.

3020B JOINTING RINGS - METALLIC GASKETS:

- Corrugated, flat or grooved metallic and filled metallic gaskets for flanges to BS EN 1092-4.
- Standard - BS EN 1514-4
- Gasket type - Corrugated metal.
- Gasket design - Self centring for type B.

3020C JOINTING RINGS FOR CAST IRON:

- Non-metallic flat gaskets for flanges to BS EN 1092-2
- Standard - BS EN 1514-1.
- Gasket type - Suitable for flanges to BS EN 545, BS EN 598 and BS EN 969.

3030A SCREWED JOINTS TO BS EN 10226:

- Use PTFE tape to BS 7786 or use hemp and jointing compound to BS 6956-5, or BS EN 751-2.

3030C SCREWED JOINTS TO BS EN 10226 WITH CHEMICAL CLEANING:

- Use hemp and jointing compound to BS 6956-5 or BS EN 751-2, prior to chemical treatment and use PTFE tape to BS 7786 after chemical treatment.

3050A WELDED JOINTS, WELDING RODS FOR STEEL PIPES:

- Gas welding, BS EN 12536; electric arc welding BS 2971.

3070# CAPILLARY JOINTS:

- Use materials as follows:
  - Solder
    - BS EN ISO 9453

        - Use lead-free fittings in accordance with BS EN 1254-1 on potable water systems.
    - Flux
        - Copper pipe - classification labelling and packaging to BS EN ISO 9454-1 and performance requirements to BS EN ISO 9454-2.
        - Stainless steel pipe - BS 5245.

3110A SPIGOT/SOCKET CAULKED JOINTS:

- Use for spun cast iron pipe.
- Yarn - Tarred hemp or spun yarn; or sterile inorganic yarn.
- Lead - Virgin blue pig lead.

3125 JOINTING EQUIPMENT FOR PRESS FITTING SYSTEM:

- Provide the manufacturer's recommended press fitting tool for use with press fitting system.

3130# PRESS FITTING JOINTING SYSTEM ON STAINLESS STEEL PIPE:

- Standard
    - To BS EN 10312.
- Size range
    - 15mm to 108mm for water.
    - 15mm to 108mm for gas.
- Dimensions
    - To BS EN 10312.
- Ends
    - With O ring seal for use with water to manufacturer's standard.
    - With O ring seal for use with gas to manufacturer's standard.
    -
- Finish - Natural.

3152A MECHANICAL JOINTS, GROOVED STAINLESS STEEL PIPES:

- Material - ductile cast iron to ASTM A536, grade 65-45-12 carbon or stainless steel type 316 conforming to ASTM A531, A743 and A744, grade CF8M
- Joint type
    - For applications where vibration attenuation and stress relief is required use flexible 2 piece housing type.
    - Use rigid 2 piece housing type where stress relief is not required .
    - For pipe sizes 350mm and above use 2 segment, wedge shaped grooved with lead-in chamfer on housing key.
- Size range
    - 20mm to 300mm, rigid: housing shall engage the bottom of the groove.

- 350mm and larger: 2 segment, wedge shaped grooved with lead-in chamfer on housing key.

- Gaskets
  - Grade 'E' EPDM.
- Finish - painted to manufacturer's standard or self colour.

3190A WALL, FLOOR AND CEILING CHROMIUM PLATED MASKING PLATES:

- Material - Copper alloy, chromium plated.
- Type - Heavy, split on the diameter, close fitting to outside of pipe.
- Fixing - Chrome raised head fixing screws.

3190B WALL, FLOOR AND CEILING PLASTIC MASKING PLATES:

- Material - Plastic.
- Fixing - Clipped with plastic lug.

4000 WORKMANSHIP, GENERAL

4010 APPEARANCE:

- Arrange all exposed pipe runs to present neat appearance, parallel with other pipe or service runs and building structure, subject to gradients for draining or venting.
- Ensure all vertical pipes are plumb or follow building line.

4020 SPACING:

- Space pipe runs in relation to one another, other services runs and building structure, allow for specified thickness of thermal insulation and ensure adequate space for access to pipe joints, etc.
- The following are recommended as minimum clearances in spacing of pipe runs:-

Between	and	Clearance (mm)
Pipeline insulated or uninsulated	Wall Finish	25
	Ceiling Finish	50
	Soffit Floor Finish	150
Insulated Pipeline	Adjacent service runs	25
Uninsulated pipeline	Adjacent service runs	50
Adjacent pipelines	Both uninsulated	150
	One uninsulated	75
	Both insulated	25

4030 GRADIENTS:

- Install pipework with gradients to allow drainage and/or air release, and to the slopes where indicated.

4040A AIR BOTTLES:

- Provide a means of venting the pipe system at all high points.
- Provide a vertical extension from the pipe approximately 100mm long, at the bore of the pipe, with a copper extension pipe with a manual vent cock located in an easily accessible position.

4040B AUTOMATIC AIR VENTS:

- Provide a means of venting the pipe system at all high points.
- Provide an automatic air vent valve with a copper outlet pipe from the valve to a tundish in an adjacent drain line or to another suitable location.

4050 DRAIN REQUIREMENTS:

- Grade pipework to allow system to be drained. Provide a means of draining the system at all low points.

4060 EXPANSION AND CONTRACTION:

- Arrange supports and fixings to accommodate pipe movement caused by the thermal changes, generally allow the flexure at changes in direction. Allow for movement at branch connections.
- For water systems, using a grooved pipework system, the proprietary flexible couplings may be used to accommodate thermal growth, contraction and for the elimination of expansion loops. The type, quantity required, locations and installation/support details of flexible couplings proposed shall be in accordance with the manufacturer's written recommendations and show on the installation drawings. Where loops are required, use flexible couplings on the loop.

4070# PIPE FITTINGS:

- Use eccentric type reductions and enlargements on horizontal pipe runs to allow draining and venting, concentric on vertical pipes, with easy transition and an included angle not exceeding 30 degree. Do not use bushes, except at radiators and at fittings where required size is not of standard manufacture. Where required, use eccentric bushes to allow draining or venting; maximum aspect ratio not to exceed two pipe sizes; above this ratio use reducing fittings. Use square tees at venting and draining points. Square elbows are not acceptable.

4110 PIPES THROUGH NON-FIRE RATED WALLS AND FLOORS:

- Enclose pipes passing through building elements, (walls, floors, partitions, etc.) concentrically within purpose made sleeves. Fit masking plates where visible pipes pass through building elements, including false ceilings of occupied rooms. Unless detailed elsewhere, carry insulation including vapour barrier where necessary through pipe sleeves.

4120A PIPE SLEEVES IN NON-FIRE RATED WALLS AND FLOORS - INSULATION NOT CARRIED THROUGH:

- Where pipe insulation is not carried through pipe sleeve, cut sleeves from material same as pipe one or two sizes larger than pipe to allow clearance. Do not use sleeves as pipe supports.
- Install sleeves flush with building finish. In areas where floors are washed down install with a 100mm protrusion above floor finish and cap off end of sleeve.

4120B PIPE SLEEVES IN NON FIRE RATED WALLS AND FLOORS WITH INSULATION CARRIED THROUGH:

- Where pipe insulation is carried through pipe sleeve, cut sleeves from material same as pipe one or two sizes larger than pipe and insulation to allow clearance. Do not use sleeves as pipe supports.
- Install sleeves flush with building finish. In areas where floors are washed down to install with a 100mm profusion above floor finish and cap off end of sleeve.

4150A TEMPORARY PLUGS, CAPS AND FLANGES:

- Seal all open ends as installation proceeds by plugs, caps or blank flanges, to prevent ingress of foreign matter.
- Use plugs of metal, plastic or wood to suit pipework material.
- In the event of such precautions not being taken, strip out pipework adjacent to open ends to demonstrate that fouling of bores has not occurred.

4160 FLANGED JOINTS GENERAL:

- Use number and diameters of bolts to standard. Fit bolts of length to give not less than one thread, or more than 3mm protrusion beyond nut when joint is pulled up.
- Fit washers under each nut.

4170 DISSIMILAR METALS:

- Take appropriate means to prevent galvanic action where dissimilar metals are connected together.

4180 PIPE RINGS AND CLIPS:

- Select type according to the application and material compatibility, give particular attention where pipes are subject to axial movement due to expansion or contraction.

4190 ANCHORS:

- Construct to resist axial stress transmitted by flexure of horizontal and vertical pipe runs or loading on vertical pipes assuming that unbalanced forces exist at all anchor points, even when these are situated in intermediate positions between two expansion loops or bellows. Use similar or compatible materials to the attached pipe.

- Provide and fix all associated backing plates, nuts, washers and bolts for attachment to or building into building structure; ensure structure is suitable for transmitted stress. Set out and line up anchors accurately in position. Inspect final grouting into building structure.

4200 SLIDE GUIDES:

- Direct movement of expansion and contraction from pipe anchor points towards loops, bellows or flexible inserts. Ensure that thrust is linear relative to the axis of pipe.
- Apply a friction reducing material between metal faces subjected to movement.

4205 PIPE SUPPORTS:

- Arrange supports and accessories for equipment, appliances or ancillary fitments in pipe runs, so that no undue strain is imposed upon pipes.
- Ensure that materials used for supports are compatible with pipeline materials.

4220 SUPPORT SPACING:

- Space supports as tables.

Pipe Size (mm)	Maximum Support Spacing (m)					
Nominal	Steel Pipe (Insulated)		Copper or Light Gauge Stainless Steel Pipe (Insulated)		Iron Pipe	
	horizontal	vertical	horizontal	vertical	horizontal	vertical
Up to 15	1.8	2.4	1.2	1.8	-	-
20	2.4	3.0	1.2	1.8	-	-
25	2.4	3.0	1.5	2.4	-	-
32	2.4	3.0	1.8	3.0	-	-
40	2.4	3.7	1.8	3.0	-	-
50	2.4	3.7	1.8	3.0	1.8	1.8
65	3.0	4.6	2.4	3.7	-	-
80	3.0	4.6	2.4	3.7	2.7	2.7
100	3.0	4.6	2.4	3.7	2.7	2.7
125	3.7	5.5	3.0	3.7	-	-
150	4.5	5.5	3.7	3.7	3.7	3.7
200	6.0	8.5	-	-	3.7	3.7
250	6.5	9.0	-	-	4.5	5.4
300	7.0	10.0	-	-	8.0	10.0
350	10.0	12.0	-	-	-	-
400	10.5	12.6	-	-	-	-
450	11.0	13.2	-	-	-	-
500	12.0	14.4	-	-	-	-
600	14.0	16.8	-	-	-	-

Pipe OD	Maximum Support Spacing (m) PVC or ABS Pipe Contents up to 20°C	
	Horizontal	Vertical
15	0.8	1.2
20	0.8	1.2
25	0.9	1.3

32	1.0	1.5
40	1.1	1.6
50	1.3	1.9
80	1.6	2.4
100	1.9	2.8
150	2.1	3.0
200	2.4	3.6
250	2.6	3.9
300	2.8	4.2

- For grooved steel and copper pipe, no individual pipe length should be left unsupported.
- Vertical support spacing
    - Check total self-weight and pressure loading against manufacturer's recommendations when using mechanical joints or end load capable flexible couplings. Ensure adequate pipe support when using non-end load capable flexible couplings.
    - Space vertical support intervals for plastics pipe at not greater than twice horizontal intervals tabulated.
    - Space external vertical PE gas pipes in accordance with the current edition of IGEM/UP/2
- Space horizontal and vertical pliable corrugated stainless steel gas pipes in accordance with the current edition of IGEM/UP/2.
- Where multiple pipe runs of differing bores are supported from a common point, use support spacing of pipe requiring closest spacing.
- Spacings given for PVC-U pipe to BS EN ISO 1452

4230A ISOLATION AND REGULATION:

- Provide valves, cocks and stop taps for isolation and/or regulation where indicated, and on:
    - Mains to isolate major sections of distribution;
    - The base of all risers and drops except in cases where one item of apparatus only is served which has its own local valve or stop tap;
    - Points of pipe connection of all items of apparatus and equipment except where the item could conveniently be isolated or regulated by valves provided for other adjacent items;
    - Draw-off fittings except where ranges of fittings are served by a common float, the isolator then being fitted with the float.

4240 MAINTENANCE AND RENEWAL:

- Arrange pipework, valves, drains, air vents, demountable joints, supports, etc., for convenient routine maintenance and renewals. Provide all runs with a regularly spaced pattern of demountable joints in the form of unions, flanges, etc., and also at items of equipment to facilitate disconnection.
- Locate valves, drains, flanges etc. in groups.

5000 WORKMANSHIP, STEEL PIPEWORK

5010A WELDING GENERAL, CLASS 1:

- Use skilled craftsman in possession of a current Certificate of Competence appropriate to type and class of work, issued by an approved authority. Mark each weld to identify operative. Submit specimen welds, representative of joints and conditions of site welding, for each

craftsman, test non-destructively, approximately 10% of butt weld joints and 5% of all other joints.
- Weld pipeline joints to BS 2633 as appropriate. Carry out non-destructive testing on 10% or as indicated.

5010B WELDING GENERAL, CLASS 2:

- Use skilled craftsman in possession of a current Certificate of Competence appropriate to type and class of work, issued by an approved authority. Mark each weld to identify operative. Submit specimen welds, representative of joints and conditions of site welding, for each craftsman, test non-destructively, approximately 10% of butt weld joints and 5% of all other joints.
- Weld pipeline joints to BS 2971 and to BESA (formerly HVCA) TR/5 Code of Practice: Welding of Carbon Steel Pipework, as appropriate.

5020 WELDED JOINTS, STEEL PIPES:

- Preparation, Making and Sealing.
  - Arc welding, conforming to BS 2971 appropriate to system temperature and pressure. Use arc welding process on piping greater than 100mm.

5030 PAINTING WELDED JOINTS, STEEL PIPES:

- Unless pipework is being prepared for galvanizing after manufacture, wire brush and paint all welds with red oxide paint when welds are complete.

5040 FLANGED JOINTS, STEEL PIPES:

- Welded Flanges
  - Weld neck and bore of 'slip on' flange.
  - Butt weld neck of welding neck flange.
- Screwed Flanges
  - Apply jointing materials. Screw on flange and expand tube into flange with roller expander where necessary.
- Preparation
  - Ensure that flange mating faces are parallel; flange peripheries are flush with each other; and bolt holes are correctly aligned.
- Making and Sealing
  - Insert jointing between flange mating faces. Pull up joint equally all round.

5050 SCREWED JOINTS, STEEL PIPES:

- Preparation
  - Ensure that plain ends are cut square. Reamer out bore at plain ends.
  - Screw plain ends, taper thread.

- Making and Sealing
    - Coat male pipe threads with jointing compound and hemp, or PTFE tape on small sizes. Immediately after applying coating, connect with female end of socket or fitting, and tighten ensuring that coating does not intrude into pipe. Leave joint clean.

5060 MECHANICAL JOINTS, GROOVED STEEL AND STAINLESS STEEL PIPES:

- Preparation
    - Ensure installers receive training from manufacturer on correct installation technique, and correct and safe use of pipe grooving tool by a factory trained manufacturer's representative. The grooving tool must be manufactured by the grooved coupling manufacturer. Ensure that cut ends are square, free of bumps, dents and score marks and that pipe outside diameter is within mechanical joint manufacturer's tolerances. Form groove in accordance with manufacturer's recommendations and to manufacturer's groove diameter tolerances. Ensure that the manufacturer supplies a grooved measuring tape to be able to check the groove is in tolerance. Manufacturer must provide certification to anyone grooving onsite or in a fabrication shop to show the correct training has been provided. Assemble joint in accordance with manufacturer's instructions.
- Making and Sealing
    - Ensure gasket material is suitable for service. For standard couplings thoroughly lubricate gasket, externally and internally, using manufacturer's recommended lubricant. Stretch gasket over one pipe end and bring pipe ends together. Slide gasket into central position over both pipe ends. Position joint half housings over gasket and insert bolts and nuts. Joints should not require any torque to show visual bolt pad to pad connection, if alternative joints are to be proposed that require torque this must be notified at the time of tender for approval. Tighten bolts to manufacturer's instructions. Check alignment of joint and pipework.
- Earth continuity
    - Full earth continuity shall be achieved by both rigid and flexible couplings. If the manufacturer's coupling selected cannot achieve this, install proprietary earth continuity clips to ensure compliance with IET regulations at each joint.
- Installation-ready couplings
    - Do not dismantle the coupling. Lubricate inner sealing lips of gasket using manufacturer's recommended lubricant. Assemble the joint by inserting the grooved pipe ends into each opening of the coupling until the ends make contact with the gasket center leg. Tighten bolts to manufacturer's instructions. Check alignment of joint and pipework.

5070A ANCHORS, STEEL PIPES, U-BOLTS:

- Provide anchors constructed using mild steel over-straps or heavy U-bolts. Secure to channel section, adequately attached to or grouted into building structure; weld longitudinal edges of strap to pipe.

5070B ANCHORS, STEEL PIPES, SLIP-ON FLANGES:

- Provide anchors constructed by passing two slip-on flanges over pipe to anchor point. Bolt together through an interposed mild steel channel section attached to or grouted into building structure, and finally weld flanges to pipe.

5090 STEEL PIPEWORK PAINTING:

- Remove scale, rust or temporary protective coating by chipping, wire brushing or use of approved solvents and paint with one coat of red oxide primer, as work proceeds.

5100 COMPRESSION JOINTS, STAINLESS STEEL PIPES:

- Use BS EN 1254-2 Type 'A' fittings.
- Preparation - Ensure that plain ends are cut square. Reamer out bore at plain ends to full bore size. Clean plain ends with fine steel wool.
- Making and Sealing - In accordance with fitting manufacturer's instructions.

6000 WORKMANSHIP, COPPER PIPEWORK

6030 COMPRESSION JOINTS, COPPER PIPES, LIGHT GAUGE:

- Preparation for fittings to BS EN 1254-2.
    - Type `A' fitting
        - Ensure that plain ends are cut square. Reamer out bore at plain ends to full bore size. Clean plain ends with fine steel wool or fine sandpaper.
- Type `B' fitting
    - Ensure that plain ends are cut square. Reamer out bore at plain ends to full bore size. Clean plain ends with fine steel wool or fine sandpaper. Then comply with manufacturer's instructions.
        - Making and Sealing - As manufacturer's instructions.

6040 CAPILLARY JOINTS, COPPER PIPES, LIGHT GAUGE:

- Preparation - Ensure that plain ends are cut square. Reamer out bore at plain ends to full bore size. Clean plain ends with fine steel wool.
- Making and sealing - Use specified flux ensuring no excess material used. Make joint in accordance with manufacturer's instructions. Clean off traces of flux when joint is completed.

6060A ANCHORS, COPPER PIPES, SADDLE CLAMPS:

- Provide anchors constructed by fitting two flanges to copper female adapters in pipe run at anchor point. Bolt together through an interposed mild steel channel section attached to or grouted into building structure.

6060B ANCHORS, COPPER PIPES, SADDLE CLAMPS :

- Anchor pipework using saddle clamps to mild steel channel section attached to or built into building structure.

7000 WORKMANSHIP, CAST/DUCTILE IRON PIPEWORK

7010 FLANGED JOINTS, CAST IRON/DUCTILE IRON PIPES:

- Preparation - Ensure that flange mating faces are parallel, flange peripheries are flush with each other and bolt holes are correctly aligned.
- Making and Sealing - Coat both sides of joint ring with jointing compound to BS 6956-5 or BS EN 751-2. Insert joint ring between flange mating faces. Pull up joint with bolts, nuts and washers, ensuring that excess compound does not intrude into the pipe. Leave joint clean.

7020 CAULKED JOINTS, CAST IRON/SPUN CAST IRON PIPES:

- Preparation - Ensure plain ends are cut square.
- Making and sealing - Caulk socket with yarn, fill socket with molten lead, allow to cool and caulk home. Ensure bore of pipe is not obstructed.

7030 FLEXIBLE JOINTS, CAST IRON PIPES:

- Preparation - Ensure that cut ends are square. Form groove to manufacturer's detail. Assemble joint in accordance with manufacturer's instructions.
- Making and Sealing - Ensure joint ring is suitable for service. Thoroughly lubricate joint ring. Slip ring over pipe end and bring ends together. Slide ring into central position over both pipe ends. Position metal half housings over joint ring and insert bolts and nuts. Tighten bolts to manufacturer's instructions. Check alignment of joint and pipework.

8000 WORKMANSHIP, PLASTIC PIPEWORK

8005 THERMOPLASTIC PIPING SYSTEMS FOR SOIL AND WASTE DISCHARGE:

- Comply with recommendations in PD CEN/TR 13801 and general installation practice given in
    - BS EN 12056-1
    - BS EN 12056-2
    - BS EN 12056-3
    - BS EN 12056-4
    - BS EN 12056-5

8006 THERMOPLASTIC PIPING SYSTEMS FOR HOT AND COLD WATER AND HEATING:

- Install pipes and associated fittings to all parts of BS 7291 in accordance with BS 5955-8 and the manufacturer's recommendations.

8010 SOLVENT WELDED JOINTS, PVC PIPES:

- Use solvent welded joints generally, ring seal joints at expansion joints and elsewhere as necessary.
- Preparation - Ensure that plain ends are cut square. Reamer out bore at plain ends. Clean plain ends with solvent cleaner.
- Making and Sealing - In accordance with fitting manufacturer's instructions.

8020 FUSION JOINTS, POLYETHYLENE PIPES:

- Preparation - Square cut plain ends. Form pipe ends for socket type joints.
- Making and Sealing - In accordance with fitting manufacturer's instructions.
- Carry out butt fusion jointing of pipes and fittings in accordance with the procedures given in BS ISO 21307.

8030 MECHANICAL FITTINGS FOR POLYETHYLENE PIPE:

- Preparation - Ensure that cut ends are square. Check wall thickness/pressure rating of fitting.
- Making and sealing - Ensure correct gasket type is used for service (e.g. water or gas). Assemble fitting in accordance with manufacturer's instructions.

8040 ANCHORS - PVC PIPES:

- Clamp pipework to mild steel channel section attached to or grouted into building structure, using PVC coated over-straps, or clamps and with a polypropylene strip between pipe and mild steel section.

8050 JOINTING POLYBUTYLENE PIPES AND FITTINGS:

- Carry out installation of polybutylene pipes and fittings in accordance with manufacturer's instructions.

8070 WORKMANSHIP, PLASTIC PIPES WITH SECONDARY CONTAINMENT AND FITTINGS FOR UNDERGROUND FUEL OIL SYSTEMS:

- Install plastic pipes with secondary containment for underground fuel oil systems in accordance with OFTEC TI/134 and the manufacturer's recommendations.

9000 WORKMANSHIP

9010 FLEXIBLE COUPLINGS AND FLANGE ADAPTERS, SLEEVE TYPE:

- Preparation - Ensure that cut ends are square and free of bumps, dents and score marks and are within manufacturer's tolerances.
- Making and sealing - Ensure gasket is suitable for service. Thoroughly lubricate gasket using manufacturer's recommended lubricant. Assemble coupling in accordance with manufacturer's instructions.
- For non-end load capable couplings, ensure that adequate pipe anchorage is provided to prevent pipe disengagement.

9020B STEAM AND CONDENSATE MAINS:

- Steam mains
    - Whenever possible install with a fall not less than 1:100 in the direction of steam flow. In circumstances where this is not practical lower falls may be acceptable but no lower than 1:250.

        - Where a stream main has to rise in the direction of flow, install with a slope not less than 1:40.
    - Condensate return lines
        - Install discharge lines from trap sets with a fall of 1:70.
        - Lift pumped condensate from receivers immediately after the pump and wherever possible size and install the return pipe with a gravity fall to the end of the line ensuring the fall is adequate to overcome frictional resistance of the pipe. Install a vacuum breaker at the top of the lift and install automatic air vents whenever the pipe has to drop/rise to avoid clashing with other services/building structure.
    - Take steam connections to plant and equipment from the top of the steam main.
    - Connect condensate discharge from trap sets into the top of the condensate main.
    - Do not use trap sets to lift condensate on equipment with automatic control valves to avoid stall in the heat exchanger.
    - Install strainers on their sides when they are part of a steam line to avoid water hammer.
    - Use thermodynamic traps on pipelines which may be subject to freezing conditions.
    - On steam mains, provide drain points comprising drain pocket and trap set trap sets discharging into condensate mains.
        - Drain pocket minimum dimensions
            - Pocket diameter - mains diameter for mains up to 100mm; 100mm diameter for main sizes 125mm - 200mm; for mains 250 diameter and above - 0.5 x mains diameter.
            - Depth - for mains up to 100mm diameter - 100mm deep; for main sizes 125mm - 200mm diameter - 150mm deep; for mains 250 diameter and above - depth to be equal to mains diameter.
        - Locate drain points at all low points on steam mains, at intervals not greater than 50m (but where possible at 30m intervals) and immediately before all automatic control valves on steam mains.

9030 PROTECTION OF UNDERGROUND PIPEWORK:

- Protect where indicated against corrosion by the application of a compatible anti-corrosive, non-cracking, non-hardening waterproof sealing tape.
- Apply, after cleaning pipework, by wrapping contrawise with two layers spirally around the pipe, ensuring a 50% minimum overlap.

9040# PROTECTION OF BURIED PIPES, MARKED:

- Provide earth cover as follows
- Water pipework
    - 900 mm minimum; 1200 mm maximum where practicable.
- Fuel oil and gas - 500 mm minimum.
- Under roadways provide minimum cover of 900 mm.
- Provide a marker tape to identify buried pipe services as indicated.

9060# INSTALLATION OF THERMALLY INSULATED UNDERGROUND PIPELINES:

- Install pre-insulated bonded steel pipelines to BS EN 253, BS EN 448, BS EN 488 and BS EN 489 in accordance with manufacturer's instructions and BS EN 13941 or BS EN 15698-1 for twin pipe systems.
- Install pre-insulated bonded flexible pipe system, with plastic service pipes to BS EN 15632-1 and BS EN 15632-2 in accordance with manufacturer's instructions.
- Install pre-insulated non bonded flexible pipe system with plastic service pipes to BS EN 15632-1 and BS EN 15632-3 in accordance with manufacturer's instructions.
- Install pre-insulated bonded flexible pipe system with metal service pipes to BS EN 15632-1 and BS EN 15632-4 in accordance with manufacturer's instructions.

9100 CORROSION PROTECTIVE TAPE:

- Apply basic cotton carrier tape saturated with petroleum hydrocarbons with inert siliceous fillers. Wind tape spirally contrawise round pipework applied and overlapped to manufacturer's recommendations.

9110 MECHANICAL PROTECTIVE TAPE:

- Apply hessian based bituminous tape over the corrosion protective tape. Wind tape spirally contrawise round pipework applied and overlapped to manufacturer's recommendations.

9120# STEELWORK PAINTING:

- Prepare supports, bearers and other uncovered steelwork as steel pipework.
- Where not exposed, paint with one coat zinc chromate or red oxide primer.

Y11 - PIPELINE ANCILLARIES

1010 SAFETY AND RELIEF VALVES, SELF OPERATED, APPLICATION:

- Safety - to discharge with rapid opening action to prevent pre-determined safe pressure being exceeded.
- Relief - to discharge with opening action proportional to increase in pressure above set pressure.
- Standards - select, supply and install safety devices in accordance with relevant parts of BS EN ISO 4126 to suit the project particular requirements.

2000 PRODUCTS/MATERIALS

2015A STOP VALVES TO BS EN 1213 FOR POTABLE WATER SUPPLIES - COMPRESSION ENDS FOR COPPER:

- Pattern - Straight.
- Material - copper alloy.
- Flow rate class - VA (straight and angle pattern stopvalves).
- End connections - Compression to BS EN 1254-2.

2015B STOP VALVES TO BS EN 1213 FOR POTABLE WATER SUPPLIES - COMPRESSION ENDS FOR PLASTICS:

- Pattern - Straight.
- Material - copper alloy.
- Flow rate class - VA (straight and angle pattern stopvalves).
- End connections - Compression to BS EN 1254-3.

2015C STOP VALVES TO BS EN 1213 FOR POTABLE WATER SUPPLIES - CAPILLARY:

- Pattern - Straight.
- Material - copper alloy.
- Flow rate class VA (straight and angle pattern stopvalves).
- End connections - Capillary to BS EN 1254-1.

2015D STOP VALVES TO BS EN 1213 FOR POTABLE WATER SUPPLIES - THREADED:

- Pattern - Straight.
- Material - copper alloy.
- Flow rate class - VA (straight and angle pattern stopvalves).
- End connections - Threaded to relevant parts of BS EN 10226

2020A THREADED ENDS GATE VALVES TO BS EN 12288:

- Series - B.
- Gate valve type - Solid or split wedge.
- Ends - Threaded to BS EN ISO 228-1 or ISO 7-1.
- Stem - Inside screw non-rising stem.

- Trim material - Manufacturer's standard.
- Operation - Handwheel.

2020B COMPRESSION ENDS GATE VALVES TO BS EN 12288:

- Series - B.
- Gate valve type - Solid or split wedge.
- Ends - Compression to BS EN 1254-2.
- Stem - Inside screw non-rising stem.
- Trim material - Manufacturer's standard.
- Operation - Handwheel.

2020C FLANGED ENDS GATE VALVES TO BS EN 12288:

- Series - B.
- Gate valve type - Solid or split wedge.
- Ends - Flanged to BS EN 1092-3.
- Stem - Inside screw non-rising stem.
- Trim material - Manufacturer's standard.
- Operation - Handwheel.

2020D LOOSE NUT/UNION ENDS GATE VALVES TO BS EN 12288:

- Series B.
- Gate valve type - Solid or split wedge.
- Ends - Loose nut/union end.
- Stem - Inside screw non-rising stem.
- Trim material - Manufacturer's standard.
- Operation - Handwheel.

2030A FLANGED GATE VALVES TO BS EN 1171:

- Valve type - Solid or split wedge.
- Seat - Metal.
- Ends - Flanged to BS EN 1092-2.
- Body and bonnet material - Grey cast iron.
- Trim category - Copper alloy faced.
- Operation - Handwheel.

2040A THREADED END GLOBE VALVES TO BS 5154:

- Series - B.
- Pattern - Straight.
- Ends - Threaded to relevant parts of BS EN 10226.
- Stem - Inside screw rising stem.
- Trim material - Manufacturer's standard.
- Operation - Handwheel.
- Options - Non-metallic renewable seat/disk rings.

2040B FLANGED GLOBE VALVES TO BS 5154:

- Series - B.
- Pattern - Straight.
- Ends - Flanged to BS EN 1092-3.
- Stem - Inside screw rising stem.
- Trim material - Manufacturer's standard.
- Operation - Handwheel.
- Options - Non-metallic renewable seat/disk rings.

2040C COMPRESSION GLOBE VALVES TO BS 5154:

- Series - B.
- Pattern - Straight.
- Ends - Compression fitting to BS EN 1254-2.
- Stem - Inside screw rising stem.
- Trim material - Manufacturer's standard.
- Operation - Handwheel.
- Options - Non-metallic renewable seat/disk rings.

2040D COMPRESSION GLOBE VALVES TO BS 5154 FOR PLASTIC PIPE:

- Series - B.
- Pattern - Straight.
- Ends - Compression fitting to BS EN 1254-3.
- Stem - Inside screw rising stem.
- Trim material - Manufacturer's standard.
- Operation - Handwheel.
- Options - Non-metallic renewable seat/disk rings.

2040E QUICK COUPLING VALVE ASSEMBLY

- 1. QUICK COUPLER BODY: it shall be factory-fabricated, bronze or brass and a two-piece type with removable upper body.
- 2. HOSE SWIVEL: hose swivel will be threaded on outlet for garden hose. The swivel shall provide 360 degree movement to ease watering in all directions.
- 3. COVER: The upper body shall be equipped with spring-loaded or weighted, durable rubber cover or stainless steel cap marked "DO NOT DRINK" in English and the same in local language. The cover shall have locking feature with two matching keys and shall be colored coded for use with unconventional water sources.
- 4. VALVE OPERATING KEY: the valve shall be opened and closed by a brass key supplied by valve manufacturer having a 25 mm male top pipe threads and 19 mm female top pipe threads outlet. The valve throat shall have a keyway with detent positions for regulating water flow. Operating keys are to be supplied at the rate of 1 per five couplings installed or fraction thereof.

2050A FLANGED GLOBE VALVES TO BS EN 13789:

- Pattern - Straight.
- Stem - Rising stem outside screw.

- Ends - Flanged to BS EN 1092-2.
- Material - Grey cast iron.

2060A PARALLEL SLIDE VALVES TO BS EN 1984:

- Ends - Flanged BS EN 1092-2.
- Stem - Rising stem.
- Valve faces - Stainless steel disc and seat.

2070A FLANGED STOP VALVES - GATE TYPE TO BS EN 1984:

- Pattern - Full bore or reduced bore.
- Materials - Cast steel body and materials to suit fluid and operating conditions.
- Ends - Flanged.
- Operation - Handwheel.

2070D THREADED STOP VALVES - GATE TYPE TO BS EN 1984:

- Pattern - Full bore or reduced bore.
- Materials - Cast steel body and materials to suit fluid and operating conditions.
- Ends - Threaded to relevant parts of BS EN 10226
- Operation - Handwheel.

2080A THREADED END BALL TYPE VALVES - SCREW DRIVER/KEY OPERATED:

- Materials - bronze or DZR copper alloy body.
- Ends - threaded to relevant parts of BS EN 10226.
- Chrome or nickel plated DZR sphere with full bore flow aperture. PTFE seats and stem seals. Anti-blowout stem.
- Operation - screw driver operated or key operated.

2080B COMPRESSION END BALL TYPE VALVES - SCREW DRIVER/KEY OPERATED:

- Materials - bronze or DZR copper alloy body.
- Ends - compression fittings to BS EN 1254-2.
- Chrome or nickel plated DZR sphere with full bore flow aperture. PTFE seats and stem seals. Anti-blowout stem.
- Operation - screw driver operated or key operated.

2080C THREADED END BALL TYPE VALVES - LEVER OPERATED:

- Materials - bronze or DZR copper alloy body.
- Ends - threaded to relevant parts of BS EN 10226.
- Chrome or nickel plated DZR sphere with full bore flow aperture. PTFE seats and stem seals. Anti-blowout stem.
- Operation - lever operated.

2080D COMPRESSION END BALL TYPE VALVES - LEVER OPERATED:

- Materials - bronze or DZR copper alloy body.
- Ends - compression fittings to BS EN 1254-2.
- Chrome or nickel plated DZR sphere with full bore flow aperture. PTFE seats and stem seals. Anti-blowout stem.
- Operation - lever operated.

2080E THREADED END BALL TYPE VALVES - LOCKSHIELD:

- Materials - bronze or DZR copper alloy body.
- Ends - threaded to relevant parts of BS EN 10226.
- Chrome or nickel plated DZR sphere with full bore flow aperture. PTFE seats and stem seals. Anti-blowout stem.
- Operation - lockshield.

2080F COMPRESSION BALL TYPE VALVES - LOCKSHIELD:

- Materials - bronze or DZR copper alloy body.
- Ends - compression fittings to BS EN 1254-2.
- Chrome or nickel plated DZR sphere with full bore flow aperture. PTFE seats and stem seals. Anti-blowout stem.
- Operation - lockshield.

2085A SCREWED END SERVICING VALVES - HANDWHEEL OPERATED:

- Materials - copper alloy body.
- Ends - screwed to BS EN 1254-2.
- Operation - handwheel operated.

2085B COMPRESSION END SERVICING VALVES - HANDWHEEL OPERATED:

- Materials - copper alloy body.
- Ends - compression fittings to BS EN 1254-2.
- Operation - handwheel operated.

2085C CAPILLARY END SERVICING VALVES - HANDWHEEL OPERATED:

- Materials - copper alloy body.
- Ends - capillary ends to BS EN 1254-1.
- Operation - handwheel operated.

2085D SCREWED END SERVICING VALVES - LEVER OPERATED:

- Materials - copper alloy body.
- Ends - screwed to BS EN 1254-2.
- Operation - lever operated.

2085E COMPRESSION END SERVICING VALVES - LEVER OPERATED:

- Materials - copper alloy body.
- Ends - compression fittings to BS 864 and BS EN 1254-2.
- Operation - lever operated.

2085F CAPILLARY END SERVICING VALVES - LEVER OPERATED:

- Materials - copper alloy body.
- Ends - capillary ends to BS EN 1254-1.
- Operation - lever operated.

2085G SCREWED END SERVICING VALVES - SCREW DRIVER OPERATED:

- Materials - copper alloy body.
- Ends - screwed to BS 864 and BS EN 1254-2.
- Operation - screw driver operated.

2085H COMPRESSION END SERVICING VALVES - SCREW DRIVER OPERATED:

- Materials - copper alloy body.
- Ends - compression fittings to BS EN 1254-2.
- Operation - screw driver operated.

2085I CAPILLARY END SERVICING VALVES - SCREW DRIVER OPERATED:

- Materials - copper alloy body.
- Ends - capillary ends to BS EN 1254-1.
- Operation - screw driver operated.

2090A LEVER OPERATED BUTTERFLY VALVES TO BS EN 593 BETWEEN FLANGES:

- Construction - provide controlled elastomer compression on flange faces; semi-lugged wafer type design, for installation between flanged pipework connections, body to suit BS EN 1092.
- Provide lever and gear operated valves with long body neck for lagging clearance.
- Seat - bonded.
- Materials - ductile iron body; stainless steel shaft; aluminium bronze or stainless steel disc to suit application; EPDM seat.
- Operation - lever and graduated notch plate.

2090B GEAR OPERATED BUTTERFLY VALVES TO BS EN 593 BETWEEN FLANGES:

- Construction - provide controlled elastomer compression on flange faces; semi-lugged wafer type design, for installation between flanged pipework connections, body to suit BS EN 1092.
- Provide lever and gear operated valves with long body neck for lagging clearance.
- Seat - bonded.
- Materials - ductile iron body; stainless steel shaft; aluminium bronze or stainless steel disc to suit application; EPDM seat.
- Operation - gear operated.

2090C LEVER OPERATED BUTTERFLY VALVES BETWEEN MECHANICAL JOINTS:

- Construction - one piece body with grooved ends or wafer type design, for installation between mechanical joints (up to 300mm only).
- Provide lever operated valves with long body neck for lagging clearance.
- Seat - bonded, pressure responsive elastomer..
- Materials - ductile iron body; stainless steel shaft; electroless nickel coated ductile iron offset disc; EPDM seat.
- Operation - lever and graduated notch plate.

2090D GEAR OPERATED BUTTERFLY VALVES BETWEEN MECHANICAL JOINTS:

- Construction - one piece body with grooved ends or wafer type design, for installation between mechanical joints. Grooves for 350mm and larger to be wedge shaped, for example, Victaulic advanced groove system (AGS).
- Provide gear operated valves with long body neck for lagging clearance.
- Seat - bonded, pressure responsive elastomer in sizes up to 300mm, disc mounted seal for 350mm and larger.
- Materials - ductile iron body; stainless steel shaft; electroless nickel coated ductile iron offset disc; EPDM seat.
- Operation - gear operated.

2090E BUTTERFLY VALVES FULLY-LUGGED TO BS EN 593:

- Construction - provide controlled elastomer compression on flange faces; fully-lugged type design, body to suit BS EN 1092.
- Provide lever and gear operated valves with long body neck for lagging clearance.
- Seat - bonded.
- Materials - ductile iron body: stainless steel shaft; aluminium bronze or stainless steel disc to suit the application; EPDM seat.
- Operation - lever and graduated notch plate or gearbox.

2110A STOP VALVES - KEY OPERATED SLUICE TYPE A TO BS 5163-1 AND BS 5163-2:

- Valve type - A
- Seat - Resilient or metal seated.
- Stem seal - Stuffing box and gland; injector packing foil; or toroidal sealing rings (O-rings).
- Operation - T key.
- Materials - Manufacturer's standard and WRAS approved.
- Options - Stem cap.

2210A LEVER OPERATED REGULATING BUTTERFLY VALVES TO BS EN 593 BETWEEN FLANGES:

- Construction - Provide controlled elastomer compression on flange faces; semi-lugged wafer type design, for installation between flanged pipework connections, body to suit BS EN 1092-2.
- Provide lever and gear operated valves with long body neck for lagging clearance.
- Seat - Bonded seat.

- Materials - Cast iron body; stainless steel shaft; aluminium bronze disc; EPDM seat.
- Operation - Infinitely variable setting with travel stops and indicator, lever operation.

2210B GEAR OPERATED REGULATING BUTTERFLY VALVES TO BS EN 593 BETWEEN FLANGES:

- Construction - Provide controlled elastomer compression on flange faces; semi-lugged wafer type design, for installation between flanged pipework connections, body to suit BS EN 1092-2.
- Provide lever and gear operated valves with long body neck for lagging clearance.
- Seat - Bonded seat.
- Materials - Cast iron body; stainless steel shaft; aluminium bronze disc; EPDM seat.
- Operation - Infinitely variable setting with travel stops and indicator, gear operation.

2210C LEVER OPERATED REGULATING BUTTERFLY VALVES TO BS EN 593 BETWEEN MECHANICAL JOINTS:

- Construction - installation between mechanical joints with grooved ends (up to 300mm only).
- Provide lever operated valves with long body neck for lagging clearance.
- Seat - bonded seat, pressure responsive elastomer.
- Materials - ductile iron body; stainless steel shaft; rubber coated ductile iron offset disc; EPDM seat.
- Operation - infinitely variable setting with travel stops and indicator, lever operation.

2210D GEAR OPERATED REGULATING BUTTERFLY VALVES TO BS EN 593 BETWEEN MECHANICAL JOINTS:

- Construction - installation between mechanical joints with grooved ends.
- Provide gear operated valves with long body neck for lagging clearance.
- Seat - bonded seat, pressure responsive in sizes up to 300mm, disc mounted seal for 350mm and larger.
- Materials - ductile iron body; stainless steel shaft; rubber coated ductile iron offset disc; EPDM seat.
- Operation - infinitely variable setting with travel stops and indicator, gear operation.

2220A THREADED END DOUBLE REGULATING VALVES TO BS 7350, COPPER ALLOY:

- BS 7350, section 3.1.
- Ends - Threaded to relevant parts of BS EN 10226.
- Material - Bronze or DZR copper alloy to BS 5154 and BS EN 12288.
- Series B; oblique or Y pattern; inside screw non-rising stem; manufacturer's standard trim material.
- Options - Provide drain plug facility; independent means for positive isolation on pressure tapping or adapter; and test and manufacturer's certificates as indicated.

2220B FLANGED DOUBLE REGULATING VALVES TO BS 7350, COPPER ALLOY:

- BS 7350, section 3.1.
- Ends - Flanged to BS EN 1092-2.
- Material - Bronze or DZR copper alloy to BS 5154 and BS EN 12288.

- Series B; oblique or Y pattern; inside screw non-rising stem; manufacturer's standard trim material.
- Options - Provide drain plug facility; independent means for positive isolation on pressure tapping or adapter; and test and manufacturer's certificates as indicated.

2220C FLANGED DOUBLE REGULATING VALVES TO BS 7350, CAST IRON:

- BS 7350, section 3.1.
- Ends - Flanged to BS EN 1092-2.
- Material - Cast iron to BS EN 13789.
- Oblique or Y pattern; copper alloy, nickel alloy or resilient valve face; rising stem outside screw or non-rising stem inside screw; manufacturer's standard materials.
- Options - Provide drain plug facility; independent means for positive isolation on pressure tapping or adapter; and test and manufacturer's certificates as indicated.

2230A THREADED ENDS FLOW MEASUREMENT DEVICES TO BS 7350, COPPER ALLOY:

- BS 7350, section 3.2 - type 3
- A fixed orifice either integral with or as a fixed orifice fitting close coupled to a double regulating globe valve.
- Ends - Threaded to relevant parts of BS EN 10226
- Material - Double regulating globe valve, bronze or DZR copper alloy to BS 7350 table 6.
- Options - Independent means for positive isolation on pressure tapping or adapter.

2230B FLANGED ENDS FLOW MEASUREMENT DEVICES TO BS 7350 TYPE 3, COPPER ALLOY:

- BS 7350, section 3.2 - type 3
- A fixed orifice either integral with or as a fixed orifice fitting close coupled to a double regulating globe valve.
- Ends - Flanged to BS EN 1092-3.
- Material - Double regulating globe valve, bronze or DZR copper alloy to BS 7350 table 6.
- Options - Independent means for positive isolation on pressure tapping or adapter.

2230C FLANGED FLOW MEASUREMENT DEVICE TO BS 7350 CAST IRON, TYPE 3:

- BS 7350, section 3.2 - type 3
- A fixed orifice either integral with or as a fixed orifice fitting close coupled to a double regulating globe valve.
- Ends - Flanged to BS EN 1092-2.
- Material - Double regulating globe valve to BS EN 13789 and close coupled fixed orifice fitting to BS 7350, table 6.
- Options - Independent means for positive isolation on pressure tapping or adapter.

2230E THREADED ENDS FLOW MEASUREMENT DEVICES TO BS 7350 TYPE 4, COPPER ALLOY:

- BS 7350, section 3.2 - type 4, variable orifice valve.
- Ends - Threaded to relevant parts of BS EN 10226

- Material - Variable orifice, double regulating globe valve, bronze or DZR copper alloy to BS EN 12288 and BS 5154 series B.
- Options - Independent means for positive isolation on pressure tapping or adapter.

2230F FLANGED FLOW MEASUREMENT DEVICES TO BS 7350 TYPE 4, COPPER ALLOY:

- BS 7350, section 3.2 - type 4, variable orifice valve.
- Ends - Flanged to BS EN 1092-3.
- Material - Variable orifice, double regulating globe valve, bronze or DZR copper alloy to BS EN 12288 and BS 5154 series B.
- Options - Independent means for positive isolation on pressure tapping or adapter.

2230G FLOW MEASUREMENT DEVICES TO BS 7350 TYPE 4, CAST IRON:

- BS 7350, section 3.2 - type 4, variable orifice valve.
- Ends - Flanged to BS EN 1092-2.
- Material - Variable orifice, double regulating globe valve, cast iron to BS EN 13789.
- Options - Independent means for positive isolation on pressure tapping or adapter.

2260A RADIATOR VALVES TO BS 2767 (TYPE 4):

- Material - Bronze or brass copper alloy body.
- Pattern - Angle or straight to suit application.
- Straight - Threaded to relevant parts of BS EN 10226 or compression to BS EN 1254-2 to suit pipework as indicated.
- Angle - Threaded to relevant parts of BS EN 10226 with one end internal and other end external with union nut and tail pipe; or compression joint to BS EN 1254-2 one end and other end externally threaded to relevant parts of BS EN 10226 with union nut and tail pipe to suit pipework as indicated.
- Options - Fit wheel valves on flow connections to radiators, and other heat emitters, without thermostatic radiator valves. Fit lockshield valves on return connections.

2270A THERMOSTATIC RADIATOR VALVES TO BS EN 215 TABLE A.1:

- Material to A.1.
- Pattern - Straight or angle pattern to suit application.
- Dimensions - Table A.1 series D.
- Thermostatic valve type - Integral sensor unless otherwise indicated.

2270B THERMOSTATIC RADIATOR VALVES TO BS EN 215 TABLE A.2:

- Material to Annex A.
- Pattern - Straight or angle pattern to suit application.
- Dimensions - Table A.2 series F.
- Thermostatic valve type - Integral sensor unless otherwise indicated.

2270C THERMOSTATIC RADIATOR VALVES TO BS EN 215 TABLE A.3:

- Material to Annex A.
- Pattern - Straight or angle pattern to suit application.
- Dimensions - Table A.3 series S.
- Thermostatic valve type - Integral sensor unless otherwise indicated.

2270D THERMOSTATIC RADIATOR VALVES TO BS EN 215 TABLE A.4:

- Material to Annex A.
- Pattern - Straight or angle pattern to suit application.
- Dimensions - Table A.4 series GB.
- Thermostatic valve type - Integral sensor unless otherwise indicated.

2270E TAMPER PROOF THERMOSTATIC RADIATOR VALVES TO BS EN 215 TABLE A.1:

- Material to Annex A.
- Pattern - Straight or angle pattern to suit application.
- Provide tamper proof TRV's.
- Dimensions - Table A.1 series D.
- Thermostatic valve type - Integral sensor unless otherwise indicated.

2270F TAMPER PROOF THERMOSTATIC RADIATOR VALVES TO BS EN 215 TABLE A.2:

- Material to Annex A.
- Pattern - Straight or angle pattern to suit application.
- Provide tamper proof TRV's.
- Dimensions - Table A.2 series S.
- Thermostatic valve type - Integral sensor unless otherwise indicated.

2270G TAMPER PROOF THERMOSTATIC RADIATOR VALVES TO BS EN 215 TABLE A.3:

- Material - Annex A.
- Pattern - Straight or angle pattern to suit application.
- Provide tamper proof TRV's.
- Dimensions - Table A.3 series S.
- Thermostatic valve type - Integral sensor unless otherwise indicated.

2270H TAMPER PROOF THERMOSTATIC RADIATOR VALVES TO BS EN 215 TABLE A.4:

- Material -Annex A.
- Pattern - Straight or angle pattern to suit application.
- Provide tamper proof TRV's.
- Dimensions - Table A.4 series GB.
- Thermostatic valve type - Integral sensor unless otherwise indicated.

2280A FLOAT OPERATED VALVES TO BS 1212-1, COPPER FLOAT:

- Piston type float operated valve to BS 1212-1.

- Connection - Side or bottom entry to suit application.
- Float - Copper to BS 1968.

2280B FLOAT OPERATED VALVES TO BS 1212-1, PLASTIC FLOAT:

- Piston type float operated valve to BS 1212-1.
- Connection - Side or bottom entry to suit application.
- Float - Plastic to BS 2456.

2290A THREADED END FLOAT OPERATED VALVES, BALANCED EQUILIBRIUM:

- WRAS approved.
- Bronze or DZR copper alloy body.
- Inlet - Threaded to relevant parts of BS EN 10226
- Spindle and head effectively guided and arranged with stops to engage with valve body and prevent over travel. Linkage fulcrum adjustable relative to vertical plane, securely locked to body tapping when set.
- Screwed plug from access cover.
- Float and lever arm.
- Spun copper float, halves brazed or welded together, with centre sleeve connecting to lever arm. For feed and expansion application use long arm type arranged to close when tank contains 150mm depth.

2315A OPEN/CLOSE CONTROL BALL VALVES:

- Valve - Open/Close valve.
- Rotary Actuator - Open/close.
- Material - Nickel-plated brass; stainless steel ball; PTFE seal; stainless steel spindle; EPDM spindle seal.
- Connections - Threaded to relevant parts of BS EN 10226.
- Ancillaries - Lever for manual operation.

2315B TWO WAY CONTROL BALL VALVES:

- Valve - Two way control valve.
- Rotary Actuator - Modulating.
- Material - Nickel-plated brass; stainless steel ball; PTFE seal; stainless steel spindle; EPDM spindle seal.
- Connections - Threaded to BS EN 10226
- Ancillaries - Lever for manual operation.

2315C THREE WAY CONTROL BALL VALVES:

- Valve - Three way control valve.
- Rotary Actuator - Modulating.
- Material - Nickel-plated brass; stainless steel ball; PTFE seal; stainless steel spindle; EPDM spindle seal.
- Connections - Threaded to relevant parts of BS EN 10226

- Ancillaries - Lever for manual operation.

2320A THREADED ENDS SWING CHECK VALVES TO BS 5154:

- Series B; horizontal pattern.
- Ends - Threaded to relevant parts of BS EN 10226
- Trim material - Manufacturer's standard.

2320B FLANGED SWING CHECK VALVES TO BS 5154:

- Series B; horizontal pattern.
- Ends - Flanged to BS EN 1092-3.
- Trim material - Manufacturer's standard.

2330A FLANGED SWING CHECK VALVES:

- Standard
- BS EN 16767
- Check valve type as defined in BS EN 736-1 - Swing.
- Body type - Flanged.
- Ends - Flanged to BS EN 1092-2.
- Orientation of pipework - Horizontal or vertical.

2330B WAFER BODY SWING CHECK VALVES:

- Standard
- BS EN 16767
- Check valve type as defined in BS EN 736-1 - Swing.
- Body type - Wafer.
- Orientation of pipework - Horizontal or vertical.

2330C FLANGED LIFT CHECK VALVES:

- Standard
    - BS EN 16767.
- Check valve type as defined in BS EN 736-1 - lift.
- Body type - flanged.
- Ends - flanged to BS EN 1092-2.
- Orientation of pipework - horizontal or vertical.

2330D WAFER BODY LIFT CHECK VALVES:

- Standard
- BS EN 16767
- Check valve type as defined in BS EN 736-1
- Check valve type to BS EN 736-1 - Lift.
- Body type - Wafer.
- Orientation of pipework - Horizontal or vertical.

2340A FLANGED SWING CHECK VALVES:

- Standard
- BS EN 16767
- Wafer pattern design suitable for installation between flanged pipework, body to suit BS EN 1092-2.
- Disc - Double disc.
- Type - Light spring type.
- Seat - Bonded.
- Materials - Cast iron body; bronze disc; EPDM seat.

2370# CHECK VALVES GLOBE STOP AND CHECK TYPE:

- Standard - BS EN 13709.
- Pattern
  - Straight.
  - Angle.
- Ends
  - Flanged to BS EN 1092-1 PN
  - Butt-weld body ends.
- Materials
  - Manufacturer's standard to suit fluid and operating conditions.
- Options
  - Body tappings and plug.
  - Indicator.

2385A COMBINED CHECK AND ANTI-VACUUM DEVICE TO PREVENT CONTAMINATION OF WATER BY BACKFLOW TO BS EN 14451:

- Standard - BS EN 14451 combined check and anti-vacuum valves.
- WRAS approval.
- Ends - Compression connections to BS EN 1254-2.

2390A COMBINED CHECK AND ANTI-VACUUM TYPE ANTI BACK SYPHONAGE VALVES:

- Bronze or DZR copper alloy body assembly with compression connections to BS EN 1254-2.
- Pattern - In-line pattern.
- Components - Stainless steel domed air inlet. Non-return valve with plastic body, rubber actuator and stainless steel to plastic seal. WRAS approval.

2391A HOSE UNION ANTI-VACUUM TYPE ANTI BACK SYPHONAGE VALVES:

- Bronze or DZR copper alloy body assembly with fittings to BS EN ISO 228-1.
- Pattern - In line pattern.
- Sizes - DN15 to DN25.

- WRAS Approval.

2395A VERIFIABLE BACKFLOW PREVENTER WITH REDUCED PRESSURE ZONE (RPZ) VALVE - GENERAL REQUIREMENTS:

- Provide an application to the local water supplier using the WRAS "RPZ Valve Assembly - Application for Installation" form.
- Obtain Water Supplier agreement that a Type BA device is a suitable means of backflow protection in the water supply system under consideration.
- Test methods and maintenance regimes shall be in accordance with the Water Suppliers requirements and any failure to comply may result in termination of supply or removal of the device. These maintenance requirements must be detailed within the project Operation & Maintenance documentation.
- The fitting must be included in the WRAS "Products and Materials Directory" and satisfy the requirements of the Regulations.
- The installer must obtain formal Water Supplier agreement that a Type BA device is a suitable means of backflow protection in the plumbing system under consideration before installation.
- Confirm that any Type BA device installed provides protection against back pressure and back siphonage at the point of use from fluids up to and including Category 4 as defined in
    - England and Wales - The Water Supply (Water Fittings) Regulations 1999 as amended, the Water Act 2014 and the Construction Products Regulations 2013.
    - Scotland - The Water Supply (Water Fittings) Byelaws 2014.
    - Northern Ireland - The Water Supply (Water Fittings) Regulations 2009.
- Comply with the stipulations and requirements set out in WRAS Approved Installation Method Document AIM-08-01.

2395B VERIFIABLE BACKFLOW PREVENTER WITH REDUCED PRESSURE ZONE (RPZ) VALVE - INSTALLATION:

- The Type BA device shall not be installed in a place or position which is:
    - Liable to flooding
    - Above electrical equipment
    - Liable to mechanical or other damage
    - Exposed to freezing - unless measures are taken to prevent the assembly from freezing
    - Concealed
- The assembly shall be:
    - Installed horizontally with the relief valve discharging downwards
    - Installed with an inline strainer fitted immediately upstream of the device - to prevent fouling of elements of the assembly
    - Installed above ground at a height enabling effective inspection and maintenance
    - Installed not less than 300mm above ground or floor level or the base of any cabinet to the underside of the exit port of the relief valve
    - Installed no more than 1500mm above ground or floor level
    - Installed with an air break between the relief outlet port and the top of the allied tundish
- Following installation the assembly shall be flushed and disinfected in accordance with BS EN 806-4 and complimentary guidance in BS 8558

- Following flushing and prior to commissioning and site test, the assembly shall be checked by the installer to ensure that the relief valve functions correctly - in accordance with the guidelines in WRAS Approved Installation Method Document AIM-08-01.

2395C VERIFIABLE BACKFLOW PREVENTER WITH REDUCED PRESSURE ZONE (RPZ) VALVE - ON-SITE INSPECTION AND TESTING:

- Site testing must only be carried out by an accredited tester approved by the Water Supplier.
- Testing shall be carried out at intervals not exceeding 12 months.
- Test data during the commissioning of the assembly and at subsequent intervals shall be entered on the "RPZ Valve Test Report Form" produced by the WRAS.
- The inspections and testing shall be in accordance with WRAS Approved Installation Method Document AIM-08-01.
- On completion of site tests, a certificate must be completed by the tester in accordance with WRAS Guidance Note and copies submitted to the water supplier and the person responsible for the device. Copies shall be included in the Operation and Maintenance Manuals, including interval periods for subsequent testing.

2395D VERIFIABLE BACKFLOW PREVENTER WITH REDUCED PRESSURE ZONE (RPZ) VALVE - RECORD OF INSTALLATION AND TEST DATA:

- Provide records for each assembly in accordance with WRAS Approved Installation Method Document AIM-08-01.
- In general, the record shall indicate the following:
    - Purpose of the assembly
    - Precise location of the assembly
    - Data pertaining to prescribed tests
    - Details of the person who carried out the test
    - Frequency of tests
    - Defects found and measures taken to remedy these defects
- The installation, commissioning and subsequent test data shall be forwarded to the Water Supplier and copies retained by the Tester and the Water Supplier's customer for a period of at least five years.

2430A SAFETY VALVES, COPPER ALLOY, SINGLE SPRING:

- Material - bronze or DZR copper alloy body.
- Standard - BS EN ISO 4126-1, BS EN ISO 4126-7.
- Ends - threaded to relevant parts of BS EN 10226
- Spring type - single spring loaded, high lift type.

2430B SAFETY VALVES, COPPER ALLOY, DOUBLE SPRING:

- Material - bronze or DZR copper alloy body.
- Standard - BS EN ISO 4126-1, BS EN ISO 4126-7.
- Ends - threaded to relevant parts of BS EN 10226
- Spring type - double spring loaded, high lift type.

2440A DRAIN COCKS, THROUGHWAY GLAND COCK:

- Bronze body threaded male to relevant parts of BS EN 10226
- Tapered plug with square shank for loose lever; bolted gland; strap and blank cap screwed on hand tight.
- Outlet to accept hose union.

2450 DRAIN COCKS - SCREWDOWN TO BS 2879, TYPE 1:

- Bronze body threaded male to relevant parts of BS EN 10226
- Screw down plug with square shank for loose lever.
- Serrated outlet to accept hosepipe, fixed or union pattern. Lockshield to accept key.

2460 DRAIN COCKS - BALL TYPE:

- Bronze or DZR copper alloy body; chrome-plated DZR ball; PTFE seats and stem seals; blow-out proof stem; strap and blank cap screwed on hand tight; serrated outlet to accept hose pipe. Lockshield key operated.

2470 VENT COCKS - TWO WAY GLAND COCK TYPE:

- Bronze body threaded to relevant parts of BS EN 10226; tapered plug with square shank for loose lever; plug position indicator; bolted gland

2480 VENT COCKS - BALL TYPE:

- Bronze or DZR copper alloy body; chrome-plated DZR ball; PTFE seats and stem seals; blow-out proof stem.
- Permanently identified ports in T-configuration.
- Lever operated.

2490 VENT COCKS - THREE WAY GLAND COCK TYPE:

- Bronze body threaded to relevant parts of BS EN 10226; tapered plug with square shank for loose lever; plug position indicator; port markings to indicate inlet, vent, waste; bolted gland.
- Port configuration, T port.

2500A THREE WAY PLUG VALVE VENT COCKS - WRENCH OPERATED:

- Cast iron body, plug and bottom cover. PTFE thrust washer.
- Ends - Flanged to BS EN 1092-2.
- T port configuration. Wrench operation.

2500B THREE WAY PLUG VALVE VENT COCKS - GEAR OPERATED:

- Cast iron body, plug and bottom cover. PTFE thrust washer.
- Ends - Flanged to BS EN 1092-2.
- T port configuration. Gear operation.

2510A AUTOMATIC AIR VENTS, FLOAT TYPE:

- Construction - Bronze or DZR copper alloy body with threaded inlet to relevant parts of BS EN 10226. Solid polypropylene float and air release valve. Ensure valve is self closing.
- Operating Conditions - Maximum temperature 130°C. Maximum pressure 10 bar.
- Options - Provide connection for piping away released air and integral non-return valve where indicated.

2515A MICROBUBBLE TEMPERATURE DIFFERENTIAL DEAERATORS:

- Construction - Vertical mild steel housing incorporating internal spiral wound copper mesh system.
- Provide automatic air release mechanism.
- Ends - Line size with flanges to BS EN 1092-1, PN 16.
- Operating conditions - Maximum temperature 110°C, maximum pressure 10 bar.

2520A LTHW PRESSURE DIFFERENTIAL DEAERATORS:

- Unit - Provide a self circulating unit connected to the system by two 15mm connections at least 500mm apart.
- Isolation - Provide valves to isolate the vessel from the main system.
- Operating conditions - Maximum temperature 110°C, maximum pressure 10 bar.

2520B CHILLED WATER PRESSURE DIFFERENTIAL DEAERATORS:

- Unit - Provide a self circulating unit connected to the system by two 15mm connections at least 500mm apart. Insulate to prevent condensation.
- Isolation - Provide valves to isolate the vessel from the main system.
- Operating conditions - Maximum temperature 110°C, maximum pressure 10 bar.

2521A CENTRIFUGAL AIR SEPARATORS:

- Construction - Vertical steel housing with offset inlet and outlet ports to remove bubbles via centrifugal force. Provide automatic air release mechanism.
- Ends - Line size with flanges to BS EN 1092-1, PN 16.
- Operating conditions - Maximum temperature 110°C, maximum pressure 10 bar.

2522A GRAVITATION DIRT SEPARATORS:

- Construction - Vertical mild steel housing with internal reservoir, sludge pipe, perforation plate and automatic air release mechanism.
- Ends - Line size with flanges to BS EN 1092-1, PN 16.
- Operating conditions - Maximum temperature 110°C, maximum pressure 10 bar.

2524A MICROBUBBLE AIR AND DIRT SEPARATORS:

- Construction - Vertical steel housing with internal large surface area mechanism to remove microbubbles via coalescence effect. Fitted with dirt drain at its lowest point for removing dirt that sinks, and fitted with a dirt drain valve on the side of the housing for removing dirt that floats on the water.

- Provide automatic air release mechanism.
- Ends - Line size with flanges to BS EN 1092-1, PN 16.
- Operating conditions - Maximum temperature 110°C, maximum pressure 10 bar.

2540# STEAM TRAPS - THERMOSTATIC TYPE, BALANCED PRESSURE:

- Bronze or DZR copper alloy body with threaded ends to relevant parts of BS EN 10226. Seamless stainless steel capsular element. Stainless steel internal components with renewable seat.
- Provide with close coupled straight pattern strainer.

2560# STEAM TRAPS - FLOAT TYPE:

- Material
    - Malleable iron body.
    - Cast iron body.
        - Stainless steel float, air vent and internal components.
- Ends - Threaded ends to relevant parts of BS EN 10226
- Mounting
    - Horizontal in-line.
- Options
    - Steam lock release facility.
    - Combined thermostatic air vent and steam lock release facilities.

2570# STEAM TRAPS - THERMODYNAMIC TYPE:

- Material
    - Stainless steel body.
    - Cast steel body.
        - Stainless steel disc with screwed cap.
- Ends
    - Threaded ends to relevant parts of BS EN 10226
- Integral strainer with access plug and stainless steel screw.
- Options
    - Isolating cover.
    - Blowdown cock fitted to strainer cap.
    - Air venting disc.

2590# STEAM TRAP FAILURE INDICATORS:

- Materials
    - Cast iron sensing chamber body.
    - Cast steel sensing chamber body.

    - Stainless steel internal sensor and sensor gasket.
- Ends - Threaded ends to relevant parts of BS EN 10226.
- Connect into assembly upstream of steam trap
- Provide plug-in solid state electronic indicators complete with batteries, number

2600# SIGHT GLASSES:

- Bronze or DZR copper alloy body threaded female to relevant parts of BS EN 10226
- Glass window.
    - Single window type.
    - Double window type.
- Locate remote from fluid discharges to avoid damage by thermal or pressure shock conditions.

2610A STEEL EXPANSION LOOPS:

- Provide expansion loop in material and finish of associated pipeline. Size to limit stress set up in material of pipe wall to 69 MPa.
- Forge bend from a single length of pipe or join by welding fittings if expansion loops are too large to manufacture in one piece.
- Where indicated, galvanize after manufacture.
- Where scheduled or detailed in the particular specification provide expansion loops installed with grooved flexible mechanical joints and elbows. The joint manufacturer shall undertake calculations for sizing of the expansion loops. Installation to be strictly in accordance with the manufacturer's instructions.

2620 EXPANSION LOOPS - COPPER:

- Provide expansion loop in material and finish of associated pipeline. Size to limit total stress set up in material of pipe wall to less than 51.5 MPa.
- Forge bend from a single length of pipe.

2630A THREADED END EXPANSION COMPENSATORS, AXIAL BELLOWS:

- Ends - Threaded to relevant parts of BS EN 10226
- Bellows - Stainless steel, multi ply or single-ply construction fitted with stainless steel inner sleeves.
- Operation - Supply expansion joints capable of not less than 2000 complete reversals of movement at the given working conditions; and of withstanding a pressure test of 1.5 times the design pressure without deformation.
- Design, manufacture and install metal bellows expansion joints in accordance with BS EN 14917.

2630B FLANGED EXPANSION COMPENSATORS, AXIAL BELLOWS:

- Ends - Flanged to BS EN 1092-1.

- Bellows - Stainless steel, multi-ply or single-ply construction fitted with stainless steel inner sleeves.
- Operation - Supply expansion joints capable of not less than 2000 complete reversals of movement at the given working conditions; and of withstanding a pressure test of 1.5 times the design pressure without deformation
- Design, manufacture and install metal bellows expansion joints in accordance with BS EN 14917.

2630D THREADED ENDS EXPANSION COMPENSATORS, ARTICULATED BELLOWS:

- Ends - Threaded to relevant parts of BS EN 10226.
- Bellows - Stainless steel, multi-ply or single-ply construction fitted with stainless steel inner sleeves.
- Operation - Supply expansion joints capable of not less than 2000 complete reversals of movement at the given working conditions; and of withstanding a pressure test of 1.5 times the design pressure without deformation.
- Design, manufacture and install metal bellows expansion joints in accordance with BS EN 14917.

2630E FLANGED EXPANSION COMPENSATORS, ARTICULATED BELLOWS:

- Ends - Flanged to BS EN 1092-1.
- Bellows - Stainless steel, multi-ply or single-ply construction fitted with stainless steel inner sleeves.
- Operation - Supply expansion joints capable of not less than 2000 complete reversals of movement at the given working conditions; and of withstanding a pressure test of 1.5 times the design pressure without deformation.
- Design, manufacture and install metal bellows expansion joints in accordance with BS EN 14917.

2630J GROOVED END EXPANSION COMPENSATORS:

- Material - ductile cast iron to ASTM A536, grade 65-45-12.
- Ends - grooved for mechanical joints.
- Operation - supply expansion joints capable of not less than 2000 complete reversals of movement at the given working conditions; and of withstanding a pressure test of 1.5 times the design pressure without deformation.
- Type - slip-type expansion compensation device, gasketed, with grooved coupling ends and 'telescoping' body.
- Size - 50mm to 150mm.
- Maximum axial end movement - 76mm.
- Limiting test pressure - 24bar pressure rated.
- Gasket - grade 'E' EPDM for water services to 110°C.
- Installation to be strictly in accordance with the manufacturer's instructions.

2630K GROOVED END MULTIPLE FLEXIBLE COUPLINGS TYPE COMPENSATORS:

- Coupling material - ductile cast iron to ASTM A536, grade 65-45-12.
- Ends - grooved for mechanical joints.

- Operation - supply expansion joints capable of not less than 2000 complete reversals of movement at the given working conditions; and of withstanding a pressure test of 1.5 times the design pressure without deformation.
- Type - multiple standard flexible grooved couplings joined by grooved end nipples.
- Axial movement - dependent on number of couplings in the compensator, refer to schedule/particular specification.
- Gasket - grade 'E' EPDM for water services to 110°C.

2650A FLANGED EPDM RUBBER FLEXIBLE CONNECTIONS UP TO 10 BAR AND 100°C:

- Material - EPDM rubber with wire reinforced cuffs.
- Steel reinforcement within the body.
- Marking - Mould date of manufacture on bellows.
- Show manufacturer and type.
- Ends - Flanges to BS EN 1092-1 that can swivel and are removable.
- Operation - Ensure flexible connections have a design life of 120 months at 100°C. Provide tie bars with rubber top hat washers where working pressure exceeds 4 bar. Supply threaded tie bars with adjustable length. Ensure flexible connections are tied when the plant is on vibration isolation mountings.

2650B THREADED END EPDM RUBBER FLEXIBLE CONNECTIONS UP TO 10 BAR AND 100°C:

- Material - EPDM rubber with wire reinforced cuffs.
- Steel reinforcement within the body.
- Marking - Mould date of manufacture on bellows.
- Show manufacturer and type.
- Ends - Threaded to relevant parts of BS EN 10226 with one union end.
- Operation - Ensure flexible connections have a design life of 120 months at 100°C. Provide tie bars with rubber top hat washers where working pressure exceeds 4 bar. Supply threaded tie bars with adjustable length. Ensure flexible connections are tied when the plant is on vibration isolation mountings.

2650C FLEXIBLE CONNECTIONS ABOVE 100°C:

- Material - Convoluted stainless steel, fully welded.
- Ends - Flanged to BS EN 1092-1. Ensure flanges can swivel.
- Operation - Ensure flexible connections are tied when the plant is on vibration isolation mountings.

2650D FLANGED EPDM RUBBER FLEXIBLE CONNECTIONS UP TO 10 BAR AND 70°C:

- Material - EPDM rubber with wire reinforced cuffs.
- Synthetic fibre reinforcement within the body.
- Marking - Mould date of manufacture on bellows.
- Show manufacturer and type.
- Ends - Flanges to BS EN 1092-1 that can swivel and are removable.

- Operation - Ensure flexible connections have a design life of 120 months at 100°C. Provide tie bars with rubber top hat washers where working pressure exceeds 4 bar. Supply threaded tie bars with adjustable length. Ensure flexible connections are tied when the plant is on vibration isolation mountings.

2650E THREADED END EPDM RUBBER FLEXIBLE CONNECTIONS UP TO 10 BAR AND 70°C:

- Material - EPDM rubber with wire reinforced cuffs.
- Synthetic fibre reinforcement within the body.
- Marking - Mould date of manufacture on bellows.
- Show manufacturer and type.
- Ends - Threaded to relevant parts of BS EN 10226 with one union end.
- Operation - Ensure flexible connections have a design life of 120 months at 100°C. Provide tie bars with rubber top hat washers where working pressure exceeds 4 bar. Supply threaded tie bars with adjustable length. Ensure flexible connections are tied when the plant is on vibration isolation mountings.

2650F FLANGED FLEXIBLE CHLOROBUTYL RUBBER CONNECTIONS UP TO 10 BAR AND 100°C:

- Material - Multi-ply reinforced chlorobutyl rubber with wire reinforced cuffs. Synthetic fibre or steel reinforcement within the body.
- Marking - Mould date of manufacture on bellows.
- Show manufacturer and type.
- Ends - Flanges to BS EN 1092-1 that can swivel and are removable.
- Operation - Ensure flexible connections have a design life of 120 months at given conditions. Provide tie bars with rubber top hat washers where working pressure exceeds 4 bar. Supply threaded tie bars with adjustable length. Ensure flexible connections are tied when the plant is on vibration isolation mountings.

2650G THREADED END CHLOROBUTYL RUBBER FLEXIBLE CONNECTIONS UP TO 10 BAR AND 100°C:

- Material - Multi-ply reinforced chlorobutyl rubber with wire reinforced cuffs. Synthetic fibre or steel reinforcement within the body.
- Marking - Mould date of manufacture on bellows.
- Show manufacturer and type.
- Ends - Threaded to relevant parts of BS EN 10226 with one union end.
- Operation - Ensure flexible connections have a design life of 120 months at given conditions. Provide tie bars with rubber top hat washers where working pressure exceeds 4 bar. Supply threaded tie bars with adjustable length. Ensure flexible connections are tied when the plant is on vibration isolation mountings.

2650H FLANGED CHLOROBUTYL RUBBER FLEXIBLE CONNECTIONS UP TO 10 BAR AND 60°C:

- Material - Multi-ply reinforced chlorobutyl rubber with wire reinforced cuffs. Synthetic fibre reinforcement within the body.
- Marking - Mould date of manufacture on bellows.
- Show manufacturer and type.
- Ends - Flanges to BS EN 1092-1 that can swivel and are removable.

- Operation - Ensure flexible connections have a design life of 120 months at given conditions. Provide tie bars with rubber top hat washers where working pressure exceeds 4 bar. Supply threaded tie bars with adjustable length. Ensure flexible connections are tied when the plant is on vibration isolation mountings.

2650I THREADED END CHLOROBUTYL RUBBER FLEXIBLE CONNECTIONS UP TO 10 BAR AND 60°C:

- Material - Multi-ply reinforced chlorobutyl rubber with wire reinforced cuffs. Synthetic fibre reinforcement within the body.
- Marking - Mould date of manufacture on bellows.
- Show manufacturer and type.
- Ends - Threaded to relevant parts of BS EN 10226 with one union end.
- Operation - Ensure flexible connections have a design life of 120 months at given conditions. Provide tie bars with rubber top hat washers where working pressure exceeds 4 bar. Supply threaded tie bars with adjustable length. Ensure flexible connections are tied when the plant is on vibration isolation mountings.

2660A TERMINAL UNIT CONNECTIONS FOR HEATING SERVICES - STAINLESS STEEL:

- Material - Stainless steel convoluted hose with stainless steel overbraiding. Carbon steel, stainless steel or copper tube end connections. Fully welded construction.
- Operation - Ensure hose length is sufficient to prevent the minimum hose bend radius from being exceeded during installation and commissioning.
- Working pressure 15 - 20 bar and temperature 95°C.

2660B TERMINAL UNIT CONNECTIONS WITH QUICK RELEASE COUPLINGS FOR HEATING SERVICES - STAINLESS STEEL:

- Material - Stainless steel convoluted hose with stainless steel overbraiding. Carbon steel, stainless steel or copper tube end connections. Fully welded construction.
- Operation - Ensure hose length is sufficient to prevent the minimum hose bend radius from being exceeded during installation and commissioning. Working pressure 15 - 20 bar and temperature 95°C.
- Options - Supply quick release couplings with screwed ends.
- Materials - Male and female nickel plated brass halves each with shut-off valve with rubber seat. Locking mechanism of stainless steel balls and stainless steel internal valve springs.

2660C TERMINAL UNIT CONNECTIONS FOR HEATING SERVICES - RUBBER:

- Material - EPDM inner liner with stainless steel wire braid. Nickel plated brass fittings with stainless steel ferrules.
- Operation - Ensure hose length is sufficient to prevent the minimum hose bend radius from being exceeded during installation and commissioning. Working pressure 15 - 20 bar and temperature 95°C.

2660D TERMINAL UNIT CONNECTIONS FOR CHILLED WATER SERVICES - STAINLESS STEEL:

- Material - Stainless steel convoluted hose with stainless steel overbraiding. Carbon steel, stainless steel or copper tube end connections. Fully welded construction. Nitrile rubber Class `O' insulation with vapour seal and end protection caps.
- Operation - Ensure hose length is sufficient to prevent the minimum hose bend radius from being exceeded during installation and commissioning. Working pressure 15 - 20 bar and temperature 95°C.

2660E TERMINAL UNIT CONNECTIONS WITH QUICK RELEASE COUPLINGS FOR CHILLED WATER SERVICES - STAINLESS STEEL:

- Material - Stainless steel convoluted hose with stainless steel overbraiding. Carbon steel, stainless steel or copper tube end connections. Fully welded construction. Nitrile rubber Class `O' insulation with vapour seal and end protection caps.
- Operation - Ensure hose length is sufficient to prevent the minimum hose bend radius from being exceeded during installation and commissioning. Working pressure 15 - 20 bar and temperature 95°C.
- Options - Supply quick release couplings with screwed ends.
- Material - Male and female nickel plated brass halves each with shut-off valve with rubber seat. Locking mechanism of stainless steel balls and stainless steel internal valve springs.

2660F TERMINAL UNIT CONNECTIONS FOR CHILLED WATER SERVICES - RUBBER:

- Material - EPDM inner liner with stainless steel wire braid. Nickel plated brass fittings with stainless steel ferrules. Nitrile rubber Class `O' insulation with vapour seal and end protection caps.
- Operation - Ensure hose length is sufficient to prevent the minimum hose bend radius from being exceeded during installation and commissioning. Working pressure 15 - 20 bar and temperature 95°C.

2670A TEST PLUGS, SELF SEALING:

- Provide DZR copper alloy self sealing test plugs for measurement of temperature and pressure, complete with captive cap for sealing when not in use. Ensure test plugs are suitable for system operating temperature and pressure.
- Provide one thermometer and pressure gauge for each range of conditions, for use with test plugs.

2670B TEST PLUGS, VALVE CONTROLLED:

- Provide DZR copper alloy self valve controlled test plugs for measurement of temperature and pressure, complete with captive cap for sealing when not in use. Ensure test plugs are suitable for system operating temperature and pressure.
- Provide one thermometer and pressure gauge for each range of conditions, for use with test plugs.

2680A THREADED PIPELINE STRAINERS, BRONZE:

- Material - Bronze to BS EN 1982.
- Ends - Threaded to relevant parts of BS EN 10226.

- Pattern - Y pattern body.
- Screen free area - Not less than 250% of pipe bore.
- Screen perforations
    - 15 to 50mm nominal size, within range 0.7 - 0.9 mm diameter.
    - 65mm and over nominal size, within range 1.5 - 1.8mm diameter.
- Internal to external flow through screen. Provide plugged connections for drain, air vent and differential pressure monitoring, threaded to relevant parts of BS EN 10226.

2680B FLANGED PIPELINE STRAINERS, BRONZE:

- Material - Bronze to BS EN 1982.
- Ends - Flanged to BS EN 1092-3.
- Pattern - Y pattern body.
- Screen free area - Not less than 250% of pipe bore.
- Screen perforations
    - 15 to 50mm nominal size, within range 0.7 - 0.9 mm diameter.
    - 65mm and over nominal size, within range 1.5 - 1.8mm diameter.
- Internal to external flow through screen. Provide plugged connections for drain, air vent and differential pressure monitoring, threaded to relevant parts of BS EN 10226.

2680C COMPRESSION PIPELINE STRAINERS, BRONZE:

- Material - Bronze to BS EN 1982.
- Ends - Compression fittings to BS EN 1254-2.
- Pattern - Y pattern body.
- Screen free area - Not less than 250% of pipe bore.
- Screen perforations
    - 15 to 50mm nominal size, within range 0.7 - 0.9 mm diameter.
    - 65mm and over nominal size, within range 1.5 - 1.8mm diameter.
- Internal to external flow through screen. Provide plugged connections for drain, air vent and differential pressure monitoring, threaded to relevant parts of BS EN 10226

2680D PIPELINE STRAINERS, CAST IRON:

- Material - Cast iron.
- Ends - Flanged to BS EN 1092-2.
- Pattern - Y pattern body.
- Screen free area - Not less than 250% of pipe bore.
- Screen perforations
    - 15 to 50mm nominal size, within range 0.7 - 0.9 mm diameter.
    - 65mm and over nominal size, within range 1.5 - 1.8mm diameter.
- Internal to external flow through screen. Provide plugged connections for drain, air vent and differential pressure monitoring, threaded to relevant parts of BS EN 10226

2680E GROOVED END PIPELINE STRAINERS, DUCTILE IRON:

- Material - Ductile iron.
- Ends - Grooved for mechanical joint.
- Pattern - Y pattern body.
- Screen free area - Not less than 250% of pipe bore.
- Screen perforations
    - 50 to 80mm nominal size, 1.6mm diameter.
    - 100mm and over nominal size, 3.2mm diameter.
- Internal to external flow through screen. Provide plugged connections for drain, air vent and differential pressure monitoring, threaded to relevant parts of BS EN 10226.

2680F GROOVED END PIPELINE SUCTION DIFFUSER STRAINERS, DUCTILE IRON:

- Body materials - ductile iron.
- Coupling gaskets - grade 'E' EPDM for water services to 110°C
- Ends - grooved for mechanical joint for jointing to pipework and flanged for jointing to pump.
- Stainless steel frame and perforated steel diffuser to provide optimum flow conditions at pump inlet.
- Unit to be complete with removable stainless steel fine mesh sleeve start-up pre-filter, bosses on either side for pressure measurement and outlet for drain connection.
- Installation to be strictly in accordance with the manufacturer's instructions.

2680G PIPELINE SUCTION GUIDE/STRAINERS:

- Body material - cast iron or ductile iron for water services to 110°C
- Ends - flanged to PN16 or PN25 to suit system maximum working pressure.
- Stainless steel strainer and fine mesh (start-up) strainer.
- Unit to be complete with flow stabilising vanes to allow connection direct to pump suction.
- Unit to be complete with removable stainless steel fine mesh sleeve start-up pre-filter.
- Provide plugged connections for drain, air vent and differential pressure monitoring.
- Installation to be strictly in accordance with the manufacturer's instructions.

2690A TUNDISHES, COPPER:

- Provide tundishes located adjacent to equipment, as indicated.
- Use 3mm minimum thickness copper sheet. Form sheet into a tapered reducing cone with a minor diameter to suit drain line.
- Major diameter nominally 50 mm larger than minor diameter, tapering at approximately 30°.

2690B TUNDISHES, MILD STEEL, GALVANIZED:

- Provide tundishes located adjacent to equipment, as indicated.
- Use mild steel sheet; galvanize after manufacture.
- Form sheet into a tapered reducing cone with a minor diameter to suit drain line.
- Major diameter nominally 50 mm larger than minor diameter, tapering at approximately 30°.

2700A GAUGES, GENERAL:

- Use dial type gauges of robust construction, enclosed in dust tight metal cases. Retain dial glass with bezels screwed to case. Finish with chromium plating.
- Use white dial scales indelibly and clearly marked with black lettering to indicate measured values. Select scale ranges which indicate `Normal' when pointer is vertical or central on scale.

2700B GAUGES, 150MM DIAMETER, FLUSH PANEL:

- Dial case - 150mm diameter, heavy pattern, finished in black stove enamel for flush mounting.
- Mount gauges with dial face in vertical plane flush to panel and conceal casing within a steel metal cubicle.

2700C GAUGES, 150MM DIAMETER, DIRECT MOUNTING:

- Dial case - 150mm diameter, heavy pattern finished in black stove enamel, for direct connection to instrument.
- Mount gauges with dial face in vertical plane and support casing by connection to instrument.

2710A TEMPERATURE GAUGES, GENERAL:

- Mercury in steel type, mounted direct in pocket.
- Use temperature gauges with pocket and provided with gland attachment on thermometer stem.
- Use separable type pockets, threaded 15/19mm BSP and manufactured from stainless steel.
- Screw pockets into tapped bosses or stools set in pipelines or vessels. Fill pockets with oil to ensure contact with thermometer bulb.
- Provide gauges with dial graduation in °C marked on alogarithmic scale. Ensure pointer movement is clockwise for increase in temperature.
- Provide sensing elements for air and gas systems, where indicated, and fix to provide airtight joints.
- Provide with metal shielding around sensing element to prevent effects of local radiation from equipment.

2710B TEMPERATURE GAUGES, MERCURY IN STEEL:

- Provide mercury in steel temperature gauge, mounted direct in pocket.

2710C TEMPERATURE GAUGES, VAPOUR PRESSURE TO BS EN 13190 FOR DIRECT MOUNTING:

- Vapour pressure type to BS EN 13190, mounted direct in pocket, with horizontal or vertical stem as appropriate.

2720 PRESSURE AND ALTITUDE GAUGES:

- Use vapour pressure type gauges to BS EN 837-1. Connect to pipeline systems via matched gauge cocks and cock connectors.
- Ensure dial graduation is from zero to between 1.5 and 3.0 times normal working pressure. Graduate in bar (gauge) on gauges reading head or working pressure, or in Pascals where pressure differences across plant items are to be established. Where fitted on boilers and pressure vessels, clearly mark with operating and maximum permissible working heads in

accordance BS 759. Elsewhere provide gauges with normal working pressure. Ensure dial movement is clockwise for an increasing in head.

- Fit syphons on steam systems.
- Provide flexible piping where gauge is subject to noticeable vibration.
- Fit gauge cocks preceding all connections to altitude and pressure gauges. Copper alloy, tapered ground plug, with ebonite lever. Unless flanged joints are required, screw inlet ends female and Fit-outlet ends with union connections allowing removal of gauges.

2730 VACUUM GAUGES:

- Use vacuum gauges complying with BS EN 837-1. Calibrate in mm of mercury.

2750A GAUGE MOUNTING BOARDS, HARDWOOD:

- Manufacture from 12mm thick, polished hardwood.
- Mount on walls or purpose made steel frames at a height approximately 1.3m above floor level.

3000 ACCESSORIES

3010A LOOSE ITEMS, KEYS FOR SPINDLE SHANK VALVES:

- Provide tee handled short shank keys suitable for each size of valve spindle shank.

3010B LOOSE ITEMS, FOR DRAIN COCKS:

- Provide lever pattern keys suitable for each drain cock and loose hose unions for drain cocks.

4000 WORKMANSHIP

4010 INSTALLATION:

- Install pipeline ancillaries in accordance with manufacturer's recommendations and BS 6683.

4020 LOCATION:

- Install valves, cocks, traps, strainers, test plugs, tundishes and other ancillary equipment in positions indicated.

4025 LOCATION OF THERMOSTATIC RADIATOR VALVES:

- Install thermostatic radiator valves in an area which reflects the space temperature. Ensure that they are not behind curtains or enclosed in heating or radiator panels.

4030 POSITIONING OF COMPONENTS:

- Locate flow and pressure measurement valves to ensure manufacturer's recommended straight length of pipe upstream and downstream of valve is provided.

4040 POSITIONING OF DOUBLE REGULATING VARIABLE ORIFICE VALVE:

- Install double regulating variable orifice valve to ensure equivalent of 10 diameters of straight pipe upstream and 5 diameters downstream of double regulating valve.

4050A POSITIONING OF CONTROL COMPONENTS:

- Install pipeline control components in accordance with manufacturer's instructions and in positions indicated.
- Insulation - Where control components are incorporated in insulated pipelines provide details of insulation method proposed, for approval.
- Supports - Arrange supports for control components to ensure no strain is imposed on components.
- Access - Arrange control components to ensure adequate access for operation and maintenance.

4070 VALVE STUFFING BOXES:

- Adjust glands of all stuffing boxes at normal plant operating temperature and pressure in accordance with manufacturer's instructions. Ensure that valve action is not impaired by over tightening.

4080A DISCHARGE CONNECTIONS, SAFETY VALVES:

- Fit pipework connections, where indicated, to provide discharge connection to Safety and Relief valves terminating at a safe discharge point.

4080B DISCHARGE CONNECTIONS, VENT COCKS:

- Fit pipework connections, where indicated, to provide discharge connection to vent cocks terminating 150mm above floor level.

4080C DISCHARGE CONNECTIONS, AIR BOTTLES:

- Fit pipework connections, where indicated, to provide bleed connection from air bottles terminating with air cock or needle valve in a convenient position.

4080D DISCHARGE CONNECTIONS, AUTOMATIC AIR VENTS:

- Fit pipework connections, where indicated, to provide discharge pipe to automatic air vents terminating over a suitable gully or drain line in a visible location.

4090 EXPANSION DEVICES:

- Where expansion and contraction cannot be accommodated by selected route, provide pipework loops, as indicated. Limit total stress set up in material of pipe wall, taking into account components due to internal pressure, tension and bending to less than 69 MPa for steel pipelines and less than 51.5 MPa for copper pipe lines.
- Where location does not permit sufficient flexibility, provide proprietary devices, as indicated.

4100 EXPANSION COMPENSATORS INSTALLATION:

- Provide anchors and guides to contain all movement and resist maximum loads imposed. Install expansion compensators strictly in accordance with manufacturer's instructions.
- Select and install metallic bellows expansion joints, test/inspect the systems after installation of the expansion joints and 1st full movement and provide certification in accordance with BS 6129-1.

4110 FLEXIBLE CONNECTIONS INSTALLATION:

- Fit rubber bellows as close to source of vibration as practicable. Ensure the pipe at other end of bellows is a fixed point. Install flexible connections strictly in accordance with manufacturer's instructions.
- Ensure flexible connections are tied when the plant is on vibration isolation mountings.

SECTION Y20 - PUMPS

1010 PUMPS:

- Provide pumps manufactured and tested in accordance with appropriate British Standard.
- With regard to safety requirements, comply with BS EN 809 and BS EN 60335-2-51 where applicable.
- Twin headed pumps to be supplied with a matching blanking plate to enable the pump to be operated with a single head fitted during maintenance or replacement of standby head/impeller.
- All pumps for floor mounting to be supplied with proprietary support foot.

1020 PUMP SELECTION AND EFFICIENCY:

- Select pump at or near most efficient part of performance curve for duty required.
- Whenever possible select single stage glanded centrifugal pumps to achieve pump efficiency in the 'optimum efficiency' area (after correcting for pump head) of the figures in the European Guide to Pump Efficiency for Single Stage Centrifugal Pumps as published by Europump 2003.
- Do not select pumps on flat part of performance curve in the anticipated range of the system when used in variable volume applications.
- Comply with EU Regulation 547/2012 on ecodesign requirements of glanded centrifugal water pumps. Minimum Efficiency Index (MEI) to be as scheduled. Pump efficiency tests shall be carried out in accordance with BS EN 16480.
- Comply with EC Regulation 641/2009 and the amendment EU Regulation 622/2012 for glandless circulators. Energy Efficiency Index (EEI) to be as scheduled.

1030 SAFETY GUARDS:

- Fit safety guards around revolving parts on close coupled and belt drive pumps.

1040 PUMP TESTING:

- Ensure pumps comply with BS EN ISO 5198 and BS EN ISO 9906 as appropriate.

2000 PRODUCTS/MATERIALS

2010C CENTRIFUGAL PUMP - CLOSE COUPLED:

- Configuration
  - Pump casing and motor mounted on a bedplate in line (end suction close coupled).
- Standards
  - BS EN ISO 9908
  - BS EN ISO 3661
  - BS EN 12756
  - BS EN 733
- Casing
  - Provide casing with drain connection fitted with plug.

- Provide threaded connections in accordance with relevant parts of BS EN 10226 for drains, vents, water jackets, cooling lines, etc.
- Provide pump with split casing to allow access to the impeller for service and maintenance.

- Impeller
  - Ensure impellers are accurately machined and finished smooth, free from blowholes and other defects and designed to be in dynamic balance at all speeds.
  - Provide open or semi-open type impellers for removal of sludge or other foreign material to prevent clogging.
  - Fix impellers to shafts to ensure that they remain firm if direction of rotation is reversed.
  - Indicate direction of rotation on pump casing.
- Shaft
  - Ensure shaft is of adequate diameter to withstand all imposed loading and has a critical speed when assembled with its impeller at least 10% above normal operating speed.
- Material
  - Casing - Cast iron to BS EN 1561.
  - Impeller - Bronze.
  - Shaft - Stainless steel.
  - Seal Housing - Cast iron to BS EN 1561.
- Bearings - Sleeve.
- Glands and seals - Mechanical.

2010D CENTRIFUGAL PUMP - DIRECT DRIVE IN-LINE:

- Configuration
  - Direct driven unit with pump body incorporating inlet and outlet connections in line, to allow pump to be mounted in pipework.
- Standards
  - BS EN ISO 9908
  - BS EN 12756
- Casing
  - Provide casing with drain connection fitted with plug.
  - Provide threaded connections in accordance with relevant parts of BS EN 10226 for drains, vents, water jackets, cooling lines, etc.
  - Provide pump with split casing to allow access to the impeller for service and maintenance.
- Impeller
  - Ensure impellers are accurately machined and finished smooth, free from blowholes and other defects and designed to be in dynamic balance at all speeds.
  - Provide open or semi-open type impellers for removal of sludge or other foreign material to prevent clogging.
  - Fix impellers to shafts to ensure that they remain firm if direction of rotation is reversed.
  - Indicate direction of rotation on pump casing.
- Shaft

- Ensure shaft is of adequate diameter to withstand all imposed loading and has a critical speed when assembled with its impeller at least 10% above normal operating speed.

- Material
  - Casing - Cast iron to BS EN 1561.
  - Impeller
  - Bronze, (for pools and fountains application, impeller shall be stainless steel)
  -
  - Shaft - Stainless steel to BS EN 10088.
  - Seal Housing - Cast iron to BS EN 1561.
- Bearings
  - Sealed-for-life or pre-packed type requiring no maintenance (in-line pumps).
- Glands and seals - Mechanical.

2010E GLANDLESS CIRCULATOR:

- Configuration
  - Glandless circulator incorporating inlet and outlet connections in line, to allow pump to be mounted in pipework.
- Pump efficiency
  - Comply with BS EN 16297-1 and BS EN 16297-2 for general requirements and procedures for testing and calculation of the Energy Efficiency Index (EEI) for stand-alone circulators.
  - Comply with BS EN 16297-1 and BS EN 16297-3 for general requirements and procedures for testing and calculation of the Energy Efficiency Index (EEI) for circulators integrated into products.
  - Include EEI of pump on name plate together with an indication of which part of BS EN 16297 was applied for the determination of the EEI.
- Motor
  - Provide electronically controlled permanent magnet type or Electronically Commutated (EC) motor.
  - Glandless circulators having a rated input of up to 200W to be tested in accordance with BS EN 16644 for structure and fluid borne noise.
- Casing
  - Provide casing with drain connection fitted with plug.
- Impeller
  - Ensure impellers are accurately machined and finished smooth, free from blowholes and other defects and designed to be in dynamic balance at all speeds.
  - Fix impellers to shafts to ensure that they remain firm if direction of rotation is reversed.
  - Indicate direction of rotation on pump casing.
- Shaft
  - Ensure shaft is of adequate diameter to withstand all imposed loading and has a critical speed when assembled with its impeller at least 10% above normal operating speed.
- Material
  - Casing - cast iron to BS EN 1561, or cast gunmetal to BS EN 1982

- Impeller - manufacturer's standard.
- Shaft - stainless steel to BS EN 10088
- Seal Housing - manufacturer's standard.

- Bearings
  - Sealed-for-life or pre-packed type requiring no maintenance (in-line pumps).

2010F CENTRIFUGAL SPLIT CASE PUMP:

- Standards
  - BS EN ISO 9908
  - BS EN 12756
- Configuration
  - Single stage, horizontally mounted, split case fire pump: Factory assembled and –tested as a one package in country of origin, electric-drive, double-suction, horizontal type. Include pump, driver, controller, etc… mounted on same base and connected with coupling.
  - Multistage, horizontally mounted, split case fire pump: Factory assembled and –tested as a one package in country of origin, electric-drive, two stage, single-suction, horizontal type. Include pump, driver, controller, etc… mounted on same base and connected with coupling.
- Casing
  - Axially split cast iron with suction and discharge flanges
  - Provide casing with drain connection fitted with plug.
  - Provide threaded connections in accordance with relevant parts of BS EN 10226 for drains, vents, water jackets, cooling lines, etc.
  - Provide pump with split casing to allow access to the impeller for service and maintenance.
- Impeller
  - Statically and dynamically balanced, and keyed to shaft.
  - Ensure impellers are accurately machined and finished smooth, free from blowholes and other defects and designed to be in dynamic balance at all speeds.
  - Fix impellers to shafts to ensure that they remain firm if direction of rotation is reversed.
  - Indicate direction of rotation on pump casing.
- Wear Rings
  - Replaceable, bronze.
- Shaft and Sleeve
  - Ensure shaft is of adequate diameter to withstand all imposed loading and has a critical speed when assembled with its impeller at least 10% above normal operating speed.
- Material
  - Casing - Cast iron to BS EN 1561.
  - Impeller - Cast bronze.
  - Shaft - Stainless Steel shaft with bronze sleeve to BS EN 10088.
  - Seal Housing - Cast iron to BS EN 1561.
- Shaft Bearings
  - Grease-lubricated ball bearings in cast-iron housing
- Seals

- Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland

- Coupling
  - Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard
- Driver
  - Electric motor.
- Finish
  - Manufacturer's standard red paint applied to factory-assembled and -tested unit before shipping Glands and seals - Mechanical.
- Nameplate
  - Complete with capacities, characteristics, and other pertinent data
- Base
  - Cast Iron Fabricated base attached to pump and driver unit with reinforcement reinforced against deflection, with drip rim, drain tapping, bolt holes, and grouting hole.

2015 VARIABLE FLOW CONTROL:

- Supply centrifugal pump with variable speed drive for variable flow control. Variable speed drive to meet the safety requirements of BS EN 61800-5-1.
- Load characteristic
  - Variable torque centrifugal pumps.
  - Constant torque for positive displacement pumps.

4000 WORKMANSHIP

4010 GENERAL:

- Comply with manufacturer's recommendations for installation of pumps. For in-line pumps ensure that motor is positioned in accordance with manufacturer's requirements.

4020 PIPELINE CONNECTIONS:

- Support pumps independently from connecting pipework to ensure no load is transmitted from pipework to pump casing on pump suction and discharge.

4040 ALIGNMENT:

- Align pump to prevent undue restraint and thrust on interconnecting pipework. Align drives to prevent undue wear and restraint on pump shaft. For belt drives, align pulleys and tension belts to prevent undue wear and out of balance forces.

4050 ACCESS:

- Locate pump within the system with adequate space around it for service and maintenance.

4060 MAINTENANCE REQUIREMENTS FOR SEWAGE PUMPS:

- For ease of service and maintenance, install submersible sewage pumps on guide rails or with lifting cables. Fit pumps with automatic discharge connections, which locate on to permanent pipework at low level in chamber.

Y21 - WATER TANKS / CISTERNS

1010 TANK DESIGN:

- Design and fabricate tanks/cisterns in accordance with British Standards.

1020 DOMESTIC STORAGE WATER CISTERNS:

- Ensure storage cisterns for domestic water purposes comply with
  - England and Wales - The Water Supply (Water Fittings) Regulations 1999 as amended, the Water Act 2014 and the Construction Products Regulations 2013.
  - Scotland - The Water Supply (Water Fittings) Byelaws 2014.
  - Northern Ireland - The Water Supply (Water Fittings) Regulations 2009.

2000 PRODUCTS/MATERIALS:

2020A SECTIONAL A1 GLASS FIBRE REINFORCED SECTIONAL TANK TO BS EN 13280:

- Class A1 - for potable water incorporating screened air inlet, vent pipe entry device for the cover, screened
- Warning and overflow pipes and particle ingress limitation between a one-piece cistern or sectional tank,
- Cover and fittings.
- Sectional tanks - External flanges.

2020B SECTIONAL A2 GLASS FIBRE REINFORCED SECTIONAL TANK TO BS EN 13280:

- Class A2 - for potable water.
- Sectional tanks - External flanges.

4000 WORKMANSHIP

4010 GENERAL:

- Store, handle and erect all in accordance with manufacturer's recommendations and relevant British Standards.
- Make due allowance for valves, fittings, access, etc., to accommodate insulation and weathering where indicated.

4020 PROTECTION AND CLEANING:

- Ensure adequate protection from damage and ingress of foreign matter to tanks and cisterns during storage, erection and commissioning. Thoroughly clean out all tanks and cisterns prior to site testing and commissioning.

4030 INSPECTION AND ACCESS:

- Install tanks and cisterns to allow internal and external surfaces to be easily inspected and cleaned.

Y23 - STORAGE CYLINDERS AND CALORIFIERS

1010 STANDARDS:

- Comply with British Standards indicated.
- Unvented hot water storage systems to be completed with "unvented kits" and pressure regulating valve to comply with Building Regulations safety requirements within Approved Document G3. Indirectly heated storage water heaters to comply with BS EN 12897.

1020 DEFINITIONS:

- Direct cylinder - a closed cylindrical vessel with domed ends.
- Indirect cylinder - a closed cylindrical vessel with domed ends having separate integral means of heating contents by annular or coil type element.
- Combination unit - an indirect/direct cylinder of double or single feed type with attached feed cistern.
- Calorifier - a closed cylindrical vessel having separate integral means of heating contents by 'U' tube chest type element.
- Primary heater - a heater mounted inside a cylinder or calorifier for transfer of heat to stored water from primary medium.
- Capacity - the volume of water storage excluding contents of any primary heater.
- Secondary working head - the vertical distance between bottom of cylinder or calorifier and water line of cistern supplying cylinder or calorifier.

2000 PRODUCTS/MATERIALS

2060A GALVANIZED STEEL CALORIFIER/STORAGE VESSEL TO BS 853-1:

- Method of heating - Hot water.
- Inspection opening
    - Size and position as shown on drawings.
    - Horizontal or vertical as shown on drawings.
    - Fixed or bolted end as shown on drawings.
- Type of heater
    - Fixed helical coil; withdrawable helical coil; or U-tube battery.
- Materials
    - Shell - galvanized steel with sacrificial anode.
    - Material test certificates to BS 853-1
    - Hydraulic test certificates to BS 853-1
- Provide connections and supports as shown on drawings and as indicated.
    - Mountings to BS 853-1
    - Fit and install pressure relief devices to relevant parts of BS EN ISO 4126 to suit the design pressure of the shell relative to the primary hot water working pressure

3000 WORKMANSHIP

3010 GENERAL:

- Store, handle and erect all in accordance with manufacturer's recommendations and relevant British Standards.
- Make allowance for valves, fittings, access etc., to accommodate insulation/weathering where indicated.

3030 PROTECTION AND CLEANING:

- Ensure protection from damage and ingress of foreign matter to cylinders and calorifiers during storage, installation and testing.

3040 INSPECTION AND CLEANING:

- Install cylinders and calorifiers such that internal surfaces and external surfaces can be readily inspected and cleaned.

Y25 - CLEANING AND CHEMICAL TREATMENT

1010 CONDITIONS FOR CLEANING AND CHEMICAL TREATMENT:

- Ensure treatment complies with statutory authority and health and safety regulations.
- Notify manufacturer's and suppliers of equipment of proposed system cleaning and chemical treatment processes. Establish if any manufacturer or supplier of equipment requires any particular cleaning and chemical treatment process due to size of waterways or materials used.
- All chemicals used are to be compatible with the metallurgy of the systems.
- Obtain local water authority approval for disposal of any waste products.

1015 METHOD STATEMENT:

- Provide a method statement covering the sequence of events, chemicals to be used etc. Statement to be provided at least two months prior to the start of any flushing and/or chemical cleaning works.

2000 PRODUCTS/MATERIALS

2010 CLEANING AND CHEMICAL TREATMENT SPECIALIST:

- Use a specialist for analysis and for design, supply, installation and operation of any system cleaning and chemical treatment process.

2020A MAINS WATER ANALYSIS:

- Obtain an analysis of mains water taken from site supply point. Check with local water authority to ensure analysis results are typical for site area and report variances for instruction; or submit a sample of water to water treatment specialist as appropriate.
- Carry out tests to establish total viable counts and Pseudomonas and sulphate reducing bacteria.
- Minimum water quality - as BSRIA BG 29/2012 Table 8.

2030A PRELIMINARY CHECKS:

- Prior to carrying out cleaning or chemical treatment process, ensure that
    - All foreign matter is removed.
    - Certified pressure tests have been carried out in the parts of the system to be cleaned. Carry out further pressure tests on the isolated sections of the system independently.
    - All water used for pressure testing is inhibited. Leave remaining pipework sections full after testing.
    - Circulation has been demonstrated and approval obtained on all parts of the system. Manipulate and leave fully open all valves other than those used to isolate sections. Carry out balancing and certification after the flushing, cleaning and passivation operations.
    - No damage can occur to any item of plant or equipment due to cleaning and chemical processes.
    - Chemicals used are compatible with system materials.
    - All items of plant and equipment subject to damage or blockage due to cleaning and chemical treatment processes are isolated or removed.

- Permanent or temporary by-passes are provided as indicated on drawings.
- Dirt pockets are installed at low points to facilitate solids removal. Supply dirt pockets with drain valves sized to pipework size.
- All drains provided have been tested and approved and that any pumping equipment associated with the drainage system is fully commissioned.
- Dead legs, that are more than 3 pipe diameters in length are looped to allow effective cleaning.
- Strainer baskets and filter media, incorporated within systems, are removed; and where necessary spool or stool pieces are installed.
- Temporary strainers and filters are installed as required for removal of solids during cleaning and chemical treatment processes.
- Strainers are clean prior to the start of the cleaning process, throughout the cleaning and on completion.
- Suitable supply and drainage points are provided with 50mm minimum connections, properly sited and installed, either valved or plugged.
- All automatic/manual air vents are fully commissioned.
- Air vents of a minimum size of 25mm are installed at the tops of large flow risers.
- All requirements of COSHH regulations are complied with during the chemical cleaning and chemical treatment of the system.
- Where required by local water authority, provide effluent tanks for storage of all waste products of cleaning and chemical treatment processes.
- Following local water authority approval, either neutralize and dispose to drain of all waste products; or ensure authorised disposal at registered sites.
- Comply with Waste Management Duty of Care: A Code of Practice and The Hazardous Waste (England & Wales) Regulations 2005 where appropriate.

2040A PROCEDURAL PRECAUTIONS FOR CLEANING AND CHEMICAL TREATMENT:

- Carry out tests to ensure that cleaning and chemical treatment processes are operating as required.
- Carry out tests to ensure that cleaning and chemical treatment processes are operating as required. and detailed in the Method Statement.
- Submit all test and sample results for certification and approval.

2040B PROCEDURAL PRECAUTIONS FOR CLEANING AND CHEMICAL TREATMENT INCLUDING TAKING SAMPLES:

- Take and test samples of the filling/flushing water and the system water, before, during and following chemical treatment and/or cleaning in accordance with BSRIA BG 29/2012, Section 3 and BS 8552.
- Submit samples to an independent specialist for analysis in accordance with BSRIA BG 29.
- Monitor water quality of systems after pre-commission cleaning up to practical completion in accordance with BSRIA BG 29/2012 Section 3.2.
- Submit all test and sample results for certification and approval.
- Ensure all contractually required samples are witnessed.

2050A WATER TREATMENT METHODS FOR HOT WATER HEATING CLOSED CIRCUIT RECIRCULATING SYSTEMS:

- Corrosion and scale control
    - Chemicals as BSRIA Guide BG 50/2013 Table 5.

- Control of microbiological fouling
    - Chemical.
    - Biocides and biodispersants. Chemicals as BSRIA BG 50/2013 Appendix C and European Biocidal Products Regulation (BPR) 528/2012.

2050B WATER TREATMENT METHODS FOR CHILLED AND CONDENSER WATER CLOSED RECIRCULATING WATER SYSTEMS:

- Corrosion control
    - Chemicals as BSRIA Guide BG 50/2013 Table 5.
- Control of microbiological fouling
    - Chemical.
    - Biocides and biodispersants. Chemicals as BSRIA BG 50/2013 Appendix C and European Biocidal Products Regulation (BPR) 528/2012.

2060A CHEMICAL INJECTION AND DOSING METHODS FOR CLOSED SYSTEMS:

- Method of introducing chemicals
    - Dosing pots.

2060B CHEMICAL CLEANING AND DOSING METHODS FOR OPEN RECIRCULATING SYSTEMS:

- Method of introducing chemicals
    - Chemical dosing for scale and corrosion inhibitors
    - Continuous; timer controller; or proportional dosing as appropriate.
    - Bleed-off control.
    - Biocide dosing - automatic dosing control.

2060C PACKAGED CHEMICAL INJECTION AND DOSING PLANT:

- Provide packaged monitoring and treatment plants.

2060D DOSING POTS - CLOSED SYSTEMS:

- Chemical feed
    - Provide feeder (dosing pots) with a tundish for filling; separate air vent with discharge tube; drain and isolating valves. Fabricate from mild steel tube to BS EN 10255, BS EN 10216 or BS EN 10217 to suit maximum working pressure of system.
- Sampling
    - Install in each water system means of taking samples as clause Y25.2070B and as follows:-
        - Chilled water systems - provide a gate valve and discharge.
        - Heating systems - provide a sample cooler with a copper coil and cooling jacket with cooling water valve and drained to waste.

2060E DOSING - OPEN SYSTEMS:

- Chemical dosing
    - Provide an interface between water treatment plant and system pumps to allow the initiation of water circulation in addition to the requirements of the building services.
    - Where control by-passes are used, set valves to allow reduced circulation but not complete isolation of the equipment.
    - Provide control of chemical inhibitors by linking the dosing pump control unit to operate on a signal from a water meter.
    - Provide skid mounted packaged equipment to feed chemical inhibitors including pre-wired controls and dosing pump, high density polyethylene tank, chemical diaphragm pump complete with all necessary valves and tubing.
    - Provide control of total dissolved solids by linking a solenoid purge valve to operate by a signal automatically received from a conductivity sensor.
- Biocide dosing
    - Provide skid mounted packaged equipment to feed two types of biocides on an automatically alternating basis including pre-wired timer controls and twin biocide diaphragm pumps complete with all necessary valves and tubing. Draw biocide chemical direct from the chemical supply drums located on the skid.
- Control
    - Provide low level alarms for all dosing units.
    - Provide BMS connections to monitor dosing and show run and alarm conditions.
- Injection manifold
    - Provide an injection manifold for use with the above water treatment equipment.
    - Connect the manifold across flow and return pipework and mount above the dosing plant modules, unless otherwise indicated.

2065 CHEMICALS - DOSING:

- Provide biocides effective against Legionella Pneumophila, algae, fungi, moulds and slime forming bacteria including pseudomonas and sulphate reducing bacteria.
- Supply biocides as recommended by water treatment specialist.
- Incorporate a bio dispersant in the programme to break up and disperse any slime masses, where required.
- Biocides to comply with European Biocidal Products Regulation (BPR) 528/2012.
- The water treatment specialist shall select the appropriate corrosion inhibitors, to minimise corrosion, and biocides to prevent any proliferation to mild steel, copper and copper alloys.
- Provide a specific inhibitor to protect aluminium when it is present in the system.
- The cleaning agent is to be specified by the water treatment specialist.

2070A MONITORING CLOSED SYSTEMS:

- For closed systems monitor system physical, chemical and bacterial levels from initial fill to practical completion in accordance with BSRIA BG 29/2012 and BS 8552.

2070B SAMPLING CLOSED SYSTEMS:

- For closed systems provide sampling points in accordance with BS 8552 and BSRIA BG 29/2012.
- Provide testing equipment to carry out tests for all inhibitors used in treatment programme indicated.
- Undertake sampling of closed systems in accordance with BSRIA BG 29/2012, Section 3 and Appendices A and B.
- Number and locations of samples in compliance with BG 29/2012, Appendix A.

2070C SAMPLING KITS:

- Provide the following test kits as appropriate
    - Boiler water test kit for steam boilers; conductivity test kit; pH test kit; inhibitor test kit; hardness test kit where a softener is installed; chloride level test kit.
- For open systems - bacteriology monitoring with use of dipslides.
- Log sheets for recording of test results, bacteriological analysis and any actions required or taken.

2070E SAMPLING HOT AND COLD WATER SERVICES:

- Standard
    - BS 8554 - Code of practice for the sampling and monitoring of hot and cold water services in buildings.
- Locate sampling points following the guidance and recommendations in the code of practice (CoP), and document these in a sampling plan in accordance with BS EN ISO 5667-1.
- Undertake sampling following construction completion in accordance with the guidance and recommendations in the CoP.
- Undertake microbiological test on samples and provide the results as part of the handover documentation to demonstrate that the systems are clear of organisms of concern. Preserve and handle samples in accordance with BS EN ISO 5667-3.

2080A CHEMICAL PROVISION, STANDARD ARRANGEMENT:

- Provide consumables for a period of 12 months.
- Where indicated, provide for supply of chemicals from containers refilled by drumless delivery system.
- Include for supply of chemicals for all systems using the basis of:
    - Open circuit systems operating at 100% load for 2080 hours per annum.
    - Closed circuit systems make-up 1% system volume/month.

3000 WORKMANSHIP

3010A FLUSHING CLOSED PIPEWORK SYSTEMS TO BSRIA BG 29:

- Carry out flushing of water systems in accordance with BSRIA Guide BG 29/2012 Pre-commission Cleaning of Pipework Systems.

- Section 4 Installation Considerations.
- Section 5 System Dynamic Flushing.

3010B FLUSHING CLOSED PIPEWORK SYSTEMS:

- Ensure all water used for pressure testing, flushing and system filling is of good quality. Clean and chlorinate temporary site mains to fill and flush closed systems in accordance with BS EN 806-4. Leave remaining pipework sections full and treated after pressure testing.
- Install all necessary pipework ancillaries to enable a specialist to carry out flushing, inspection and witnessing of water systems in accordance with BSRIA Guide BG 29/2012 Pre-commission cleaning of pipework systems. Connections between new and existing systems in accordance with BG 29/2012 Section 7.
- Temporary connection from the mains must be in compliance with
  - WRAS advisory topics B09 or B22.
  - England and Wales - The Water Supply (Water Fittings) Regulations 1999 as amended, the Water Act 2014 and the Construction Products Regulations 2013.
  - Scotland - The Water Supply (Water Fittings) Byelaws 2014.
  - Northern Ireland - The Water Supply (Water Fittings) Regulations 2009.
  - BSRIA BG 29/2012 Table 3 for pipe sizes when using mains water for flushing or installation of a temporary tank and pump arrangement shall be provided.
- Flush systems using mains water until the water is clear.

3010D FLUSHING SERVICES SUPPLYING WATER FOR DOMESTIC USE:

- Domestic water systems are to be flushed and disinfected in accordance with the requirements of BS EN 806-4, complimentary guidance in BS 8558 and PD 855468 and to the satisfaction of the local water supply authority.

3020A TESTING AND PURGING GAS PIPEWORK - INDUSTRIAL AND COMMERCIAL INSTALLATIONS:

- Comply with IGE/UP/1 Strength and tightness testing and direct purging of industrial and commercial gas installations.

3020B TESTING AND PURGING GAS PIPEWORK - SMALL LOW PRESSURE INDUSTRIAL AND COMMERCIAL INSTALLATIONS:

- For systems having a volume not exceeding $1m^3$ comply with IGE/UP/1A Strength and tightness testing and direct purging of small low pressure industrial and commercial natural gas installations.

3020C TESTING AND COMMISSIONING GAS INFRASTRUCTURE TO BS EN 12327:

- Carry out pressure testing and commissioning of gas infrastructure (external to buildings) up to the ECV fitted on the end of the gas service owned by the Gas Transporter in accordance with BS EN 12327.
- Purge each system using nitrogen or carbon dioxide

- This operation is to prove the continuity of the pipework, remove any cutting fluid and ensure that the nozzles are clear.
- Flimsy paper bags are to be attached to all nozzles during the purge and removed upon completion of the purge.

3030A CHEMICAL CLEANING AND SOLIDS REMOVAL - INHIBITED ACID:

- Carry out chemical cleaning procedure in accordance with BSRIA Guide BG 29/2012 Pre-commission Cleaning of Pipework Systems.

3030B CHEMICAL CLEANING AND SOLIDS REMOVAL - FORMULATED PRODUCTS:

- Carry out chemical cleaning procedure in accordance with BSRIA Guide BG 29/2012 Pre-commission Cleaning of Pipework Systems.

3035 CLEANING AND CHEMICAL TREATMENT REGIME:

- The specialist shall submit a method statement prior to commencing work which fully prescribes the proposed regime and sequence for the flushing, cleaning and chemical treatment of all closed and condenser water systems. The following shall be considered in preparation of the method statement:
  - Delay filling the pipework for the first time for as long as possible.
  - If any pipework is to be wet for more than 2 weeks prior to cleaning, treat the fill water with biocide and bio-dispersant.
  - Take samples for microbiological analysis in accordance with BG 29/2012 Section 3.
  - If sample results are poor, undertake a biocide wash on all previously wetted areas after the initial flush. Biocide treated water should be drawn into any previously wetted terminal unit coils slowly (which have been isolated for the clean) to avoid the introduction of debris, after which the coils should be isolated again.
  - During the initial flush flows should be maximised, recorded and witnessed. Batch work on terminal unit by-passes should be carefully undertaken in accordance with BSRIA BG 29/2012, and the correct number of terminal unit by-passes opened at any one time in order to maximise flow along the horizontal runs.
  - Static flushing.
  - Dynamic flushing.
  - Degreasing.
  - Biocide wash.
  - Removal of surface oxides (for systems with carbon steel components).
  - Effluent disposal/final flushing.
  - Neutralisation (for inhibited acid cleans only).
  - Passivation.
  - Corrosion inhibitor and final biocide dosing.
  - Monitoring and sampling of water to practical completion.

3040 DISINFECTION - GENERAL:

- After flushing process, carry out disinfection of water services systems in accordance with BS EN 806-4 and complimentary guidance in BS 8558 and PD 855468.
- Prior to disinfection ensure each system is flushed, cleaned and drained.

- Provide temporary connections to system terminal points suitable for introduction of disinfection chemicals and fluids and 22mm minimum valved drain connection on incoming main immediately downstream of mains isolating valve.
- Fill system with clean, fresh water.
- If the building is not occupied immediately after disinfection, put in hand a system for flushing all outlets to ensure system remains suitable for use when required.
- Repeat disinfection of potable water system immediately prior to handover if required.
- Immediately prior to occupation, retake samples and submit for analysis and report.

3050 DISINFECTION - HOT AND COLD WATER SERVICES SYSTEMS:

- Carry out the following operations in accordance with BS EN 806-4 and complimentary guidance in BS 8558 and PD 855468.
    - Flush system and introduce sterilisation chemical.
    - Agree a list of sentinel points (outlets in a water system that poses the highest risk from infection) prior to disinfection and take samples from these points to ensure correct chlorine concentration.
    - Leave system to stand for period of time indicated by the chemical manufacturer.
    - Repeatedly flush system with clean water until all traces of chlorine have been removed - leave system filled.
    - Submit samples to registered laboratory for microbiological analysis and report.
- Certificate of conformity
    - Immediately prior to handover, retake samples and submit for analysis and report.
- Where necessary repeat disinfection of potable water system immediately prior to handover.

3060 DISINFECTION - WATER STORAGE SYSTEMS:

- Carry out the following operations in accordance with BS EN 806-4, complementary guidance in BS 8558, PD 855468 and HSE L8 Legionnaires' Disease: The control of legionella bacteria in water systems ACOP and all parts of HSG274 (for technical guidance).
- Carry out operations on all water storage tanks and cisterns, cold and hot.
- Carry out procedures as for mains water systems.

3080 SERVICE VISITS:

- Provide monthly service visits for one full year by a fully qualified chemist, to carry out the following:-
    - Review water analysis records, correspondence and reports since previous visit.
    - Test water samples on-site for hardness; all inhibitors; dissolved solids; pH; total alkalinity.
    - Check performance of feeding equipment, softeners, and testing equipment on-site.
    - Submit a written report.
    - Undertake a sampling of closed systems in accordance with BS 8552.
    - Carry out micro-biological analysis using dipslides.
    - Frequency of service visits - monthly.

3090 DOCUMENTATION:

- Provide number of copies as indicated of hard cover binders containing details of
    - Programme outlines.
    - Purpose of chemical treatment.
    - Chemicals used and quantity.
    - On site testing procedures.
    - Control limits of tests.
    - Equipment data and drawings.
    - Product notes and material safety data sheets for all chemicals used.
- Provide a complete training programme for site operatives covering
    - Methods of basic water testing.
    - Explanation of results obtained.
    - Actions to be taken on test results.

Y30 - AIR DUCTLINES AND ANCILLARIES

1010 DUCTWORK INSTALLATION STANDARDS:

- Carry out construction and installation of ductwork in accordance with, as appropriate
  - DW/144
  - DW/154
  - DW/172
  - DW/191
  - BS 9999
  - BS EN 1507
  - BS EN 12237
  - BS EN 13403

1020 DUCTWORK DIMENSIONS:

- Sizes of ductwork are internal dimensions. Where applicable make allowance for any internal lining.

1030 ELECTRICAL BONDING TERMINAL:

- Ensure an electrical bonding terminal is provided suitable for connection of a main protective conductor complying with BS 7671, clause 544.1.

2000 DUCTWORK FABRICATION/MATERIALS

2010# DESIGN INFORMATION:

- Supply ductwork in accordance with classification in DW/144 and DW/154, BS EN 1507 Table 1 and BS EN 12237 Table 2.
- Ductwork classification and air leakage limits
  - Low pressure - Class A - Positive. (0.027 x $p^{0.65}$.l/s/m^2 duct surface) (Max air velocity - 10m/s)
  - Low pressure - Class A - Negative. (0.027 x $p^{0.65}$.l/s/m^2 duct surface) (Max air velocity - 10m/s)
  - Medium pressure - Class B - Positive. (0.009 x $p^{0.65}$.l/s/m^2 duct surface) (Max air velocity - 20m/s)
  - Medium pressure - Class B - Negative. (0.009 x $p^{0.65}$.l/s/m^2 duct surface) (Max air velocity - 20m/s)
  - High pressure - Class C - Positive. (0.003 x $p^{0.65}$.l/s/m^2 duct surface) (Max air velocity - 40m/s)
  - High pressure - Class C - Negative. (0.003 x $p^{0.65}$.l/s/m^2 duct surface) (Max air velocity - 40m/s)
  - High pressure - Class D - Positive. (0.001 x $p^{0.65}$.l/s/m^2 duct surface) (Max air velocity - 40m/s)

- High pressure - Class D - Negative. (0.001 x $p^{0.65}$.l/s/m^2 duct surface) (Max air velocity - 40m/s)

2030A HIGH PRESSURE DUCTWORK AIR LEAKAGE TESTING:

- Carry out ductwork air leakage testing on all high pressure ductwork in accordance with DW/144 as procedures set out in DW/143.

2030B MEDIUM PRESSURE DUCTWORK AIR LEAKAGE TESTING:

- Test 10% of medium pressure ductwork (selected at random) in accordance with DW/144 as procedures set out in DW/143, or;
- Test indicated or scheduled % of the medium pressure ductwork for air leakage. Test at the pressure recommended in DW/144 as procedures set out in DW/143 for the classification of the selected ductwork. Carry out the tests as the work proceeds and prior to application of thermal insulation.
- If the test fails, pressure test two further sections as indicated. If the further tests fail, apply remedial action to the complete ductwork system.
- Provide documented evidence of the calculations used to arrive at the allowable loss for the section to be tested and ensure the client or his agent witnesses and signs the results of the tests.
- Testing plant items, DW/144.

2030C LOW PRESSURE DUCTWORK AIR LEAKAGE TESTING:

- Test indicated or scheduled % of the low pressure ductwork for air leakage. Test at the pressure recommended in DW/144 for the classification of the selected ductwork as procedures set out in DW/143. Carry out the tests as the work proceeds and prior to application of thermal insulation.
- If the test fails, pressure test two further sections as indicated. If the further tests fail, apply remedial action to the complete ductwork system.
- Provide documented evidence of the calculations used to arrive at the allowable loss for the section to be tested and ensure the client or his agent witness and signs the results of the tests.
- Testing plant items as DW/144.

2035 STRENGTH AND LEAKAGE TESTING OF CIRCULAR SHEET METAL DUCTWORK:

- Carry out ductwork strength and air leakage testing on circular sheet metal ductwork in accordance with BS EN 12237.
- Test procedure shall be as detailed in BS EN 12237, Section 7.
- Produce a test report as detailed in BS EN 12237, Section 8.

2036 STRENGTH AND LEAKAGE TESTING OF RECTANGULAR SHEET METAL DUCTWORK:

- Carry out ductwork strength and air leakage testing on rectangular sheet metal ductwork in accordance with BS EN 1507.
- Test procedure shall be detailed in BS EN 1507.
- Produce a test report as detailed in BS EN 1507.

2065 KITCHEN EXTRACT SYSTEMS:

- Comply with BESA DW/172 Appendix D' and DW/144.
- Comply with Section 7 of BESA TR/19 for facilities and specific requirements for cleaning.
- Access doors for cleaning (with grease tight gaskets) shall be installed at every bend and connection and at every 3m on straight lengths of ductwork. All joints shall be grease-tight.
- The entire system installation shall comply with all relevant Building Regulations and any specific requirements of the Building Control and Fire Officer.
- Ductwork -:Carbon-Steel Sheets: DW/144, cold-rolled sheets; commercial quality; with oiled, exposed matte finish..

2070 MAN ACCESS AND SAFETY BARS:

- Man access is required where indicated on drawings. Ensure that duct floor is of sufficient strength to comply with safety standards.
- Provide safety bars where indicated at the top of risers.

2100# PLASTICS DUCTWORK TO DW/154:

- Manufacture and install plastic ductwork in accordance with DW/154.
- Material
    - PVC-U (Unplasticized polyvinyl chloride).
    - PPS (Self extinguishing polypropylene).
    - FBPP (Fabric backed polypropylene sheet).
    - PVC-U/GRP (Composite laminate of unplasticised polyvinyl chloride and glass reinforced plastic).
    - PVC-U/FOAM/GRP (Composite laminate of unplasticised polyvinyl chloride, rigid polyurethane self extinguishing foam and glass reinforced plastic).
    - FBPP/FOAM/GRP (Composite laminate of fabric backed polypropylene sheet, rigid polyurethane self extinguishing foam and glass reinforced plastic).
- Construction
    - Rectangular ducts DW/154 Part 3.
        - Provide internal stiffeners.
    - Circular ducts DW/154 Part 4.

2100M PRE-INSULATED DUCTWORK TO BS EN 13403:

- Fabrication/Installation in accordance with manufacturer's technical manuals.
- Material - Closed cell phenolic foam insulation boards.
- Construction - Manufacturer's fabrication/installation manuals.
- Provide internal stiffeners as necessary.

2110A FIRE PROTECTION WITH FIRE DAMPERS:

- Method of protection where ventilation ducts pass through fire-separating elements

- BS 9999 method 1 and method 4 protection using fire dampers and/or automatically actuated fire and smoke dampers triggered by smoke detectors.

- Installation to comply with
  - BESA DW/144 and DW/145
  - Building Regulations Approved Document B
  - BS EN 15650 Ventilation for buildings. Fire dampers
  - Relevant parts of BS EN 1366, BS EN 13501 and BS EN 12101

2110B FIRE PROTECTION WITH FIRE RESISTING ENCLOSURES:

- Method of protection where ventilation ducts pass through fire-separating elements
  - BS 9999 method 2 using fire-resisting enclosures.
- Installation to comply with
  - BESA DW/144
  - Building Regulations Approved Document B
  - Relevant parts of BS EN 1366, BS EN 13501 and BS EN 12101

2110C FIRE RESISTING SMOKE AND HEAT CONTROL DUCTWORK TESTED TO BS 476-24:

- Ensure complete ductwork system complies with the requirements of BS 476-24 for testing, BS 9999 and Building Regulations Approved Document B.
- Method of protection where ventilation ducts pass through fire-separating elements
  - BS 9999 method 3: protection using fire-resisting ductwork.
- Duct constructed to BESA DW/144 has no tested fire resistance, therefore when using protective cladding materials, construction of base duct must comply with the actual construction of the tested duct specimen and cladding material.
- Drop rods and exposed bearers to be insulated in accordance with manufactures recommendations and instructions.
- Where a vapour barrier is required, all exposed edges and penetrations through the foil should be sealed using soft self-adhesive aluminium foil tape.

2110D FIRE RESISTING DUCTWORK TESTED TO BS 476-24:

- Ensure complete ductwork system complies with the requirements of BS 476-24, BS 9999 and Building Regulations Approved Document B.
- Method of protection where ventilation ducts pass through fire-separating elements
  - BS 9999 method 3: protection using fire-resisting ductwork
- Supply and install fire rated ductwork using fire resisting ductwork using either fire protection cladding on-site, factory applied fire resisting finish or factory manufactured fire rated ductwork as detailed elsewhere in this specification. Ductwork to be in accordance with BESA DW/144.
- Duct constructed to BESA DW/144 has no tested fire resistance therefore when using protective cladding materials, construction of base duct must comply with the actual construction of the tested duct specimen and cladding material.
- Insulation system to be independently tested and carry current valid certification to provide fire protection fully in accordance with the requirements of duct Type A and duct Type B of BS 476-24 and BS 9999.

- Drop rods and exposed bearers to be insulated in accordance with manufacturers recommendations and instructions.
- Where a vapour barrier is required, all exposed edges and penetrations through the foil should be sealed using soft self-adhesive aluminium foil tape.

2110E FIRE RESISTING DUCTWORK TESTED TO BS EN 1366:

- Supply and install fire resisting ductwork using either fire protection cladding on-site, factory applied fire resisting finish or factory manufactured fire rated ductwork, as detailed elsewhere in this specification. Ductwork to be in accordance with BESA DW/144.
- Duct constructed to BESA DW/144 has no tested fire resistance, therefore when using protective cladding materials, construction of base duct must comply with the actual construction of the tested duct specimen and cladding material.
- Method of protection where ventilation ducts pass through fire-separating elements
    - BS 9999 method 3: protection using fire-resisting ductwork.
- Ensure complete ductwork system complies with EN testing requirements to BS EN 1366-1, be tested by a UKAS accredited notified body, or body accredited by the local Authorities Having Jurisdiction and comply with Building Regulations Approved Document B.
- Classification documents to be in accordance with BS EN 13501-3 for ventilation ducts, the ductwork providing either duct Type A (fire outside) or duct Type B (fire inside). Documents to confirm that systems are suitable for horizontal and vertical applications; and in both rectangular and circular profiles; and any size limitations under the relevant BS EN 1366 test part must be confirmed.
- Where the ductwork passes between fire compartments, fire stopping shall be carried out by the specialist in accordance with the ductwork manufacturer's recommendations; and the ductwork shall be reinforced in line with that used within the actual fire test; and be relevant to flexible or rigid wall / floor constructions. The ductwork shall be stiffened to prevent deformation of the duct in a fire to maintain the cross-sectional area of the duct and ensure that the fire rated penetration seal around the duct is not compromised.
- The specialist ductwork contractor shall be responsible for the design and sizing of the drop rods and bearers (and their centres) for the fire resisting ductwork to suit the fire duration scheduled.
- Drop rods and exposed bearers to be insulated in accordance with manufacturers recommendations and instructions.
- All fire insulation, sealants, gaskets and flexible joints must be non-flammable when tested.
- Where a vapour barrier is required, all exposed edges and penetrations through the foil should be sealed using soft self-adhesive aluminium foil tape.

2110F FIRE RESISTING AND SMOKE / HEAT CONTROL DUCTWORK TESTED TO BS EN 1366:

- Supply and install fire resisting ductwork using either fire protection cladding on-site, factory applied fire resisting finish or factory manufactured fire rated ductwork, as detailed elsewhere in this specification. Ductwork to be in accordance with BESA DW/144.
- Duct constructed to BESA DW/144 has no tested fire resistance, therefore when using protective cladding materials, construction of base duct must comply with the actual construction of the tested duct specimen and cladding material.
- Method of protection where ventilation ducts pass through fire-separating elements
    - BS 9999 method 3: protection using fire-resisting ductwork.

- Ensure complete ductwork system complies with EN testing requirements to BS EN 1366-1, BS EN 1366-8 or BS EN 1366-9 depending on system function, be tested by a UKAS accredited notified body, or body accredited by the local Authorities Having Jurisdiction and comply with Building Regulations Approved Document B. Smoke extract ducts to conform to the requirements of BS EN 12101-7.
- Classification documents to be in accordance with BS EN 13501-3 for ventilation ducts and BS EN 13501-4 for smoke control ducts sections. Documents to confirm that systems are suitable for horizontal and vertical applications; and in both rectangular and circular profiles; and any size limitations under the relevant BS EN 1366 test part must be confirmed.
- The ductwork providing either duct Type A (fire outside), duct Type B (fire inside) or duct Type C (fire inside smoke control duct). All smoke extract ductwork to be capable of retaining a cross-sectional area of 90% under fire conditions in accordance with BS EN 1366-8 for multi compartment smoke extract systems.
- Where the ductwork passes between fire compartments, fire stopping shall be carried out by the specialist in accordance with the ductwork manufacturer's recommendations; and the ductwork shall be reinforced in line with that used within the actual fire test; and be relevant to flexible or rigid wall / floor constructions. The ductwork shall be stiffened to prevent deformation of the duct in a fire to maintain the cross-sectional area of the duct and ensure that the fire rated penetration seal around the duct is not compromised.
- The specialist ductwork contractor shall be responsible for the design and sizing of the drop rods and bearers (and their centres) for the fire resisting ductwork to suit the fire duration scheduled.
- Drop rods and exposed bearers to be insulated in accordance with manufacturers recommendations and instructions.
- All fire insulation, sealants, gaskets and flexible joints must be non-flammable when tested.
- Where a vapour barrier is required, all exposed edges and penetrations through the foil should be sealed using soft self-adhesive aluminium foil tape.

2120A INTERNAL THERMAL/ACOUSTIC INSULATION:

- Fit internal linings at works in accordance with DW/144.

2130# PRE-INSULATED EXTERNAL THERMAL/ACOUSTIC DUCTWORK:

- Thickness - to meet maximum permissible heat loss (warm air ducts) - 16.34 W/m^2 and heat gain (chilled/dual-purpose air ducts) - 6.45 W/m^2 in accordance with BS 5422 and Non-Domestic Heating, Cooling and Ventilation Compliance Guide, and Approved Document L2A/L2B.

2130B PRE-INSULATED ALUMINIUM DUCTWORK:

- External aluminium - Thickness 8mm.
  - Finish - Embossed, protected with polyester lacquer
- Internal aluminium - Thickness 8mm.
  - Finish - Embossed, protected with polyester lacquer
- Insulation - 20mm polyurethane.

2140A HANGERS AND SUPPORTS:

- Provide hangers and supports throughout in accordance with DW/144; DW/154 Part 5; or DW/191 Section 7 as appropriate.
- Comply with BS EN 12236.

2150A SUPPORT OF AIR TERMINAL UNITS:

- Support air terminal units and their plenums by the ceiling grids, as DW/144.

3000 ACCESSORIES AND COMPONENTS

3010 CONSTRUCTION AND FINISHES:

- Ensure that materials of accessories are compatible with ductwork and that finishes of accessories comply with any special requirements for ductwork.
- Ensure casing losses of components are compatible with ductwork in which they are incorporated.

3020A METAL DUCTWORK INSPECTION/SERVICING ACCESS OPENINGS:

- Provide access/inspection openings in accordance with DW/144.

3020C PLASTIC DUCTWORK INSPECTION/SERVICING ACCESS OPENINGS:

- Provide access openings in accordance with DW/154 Part 6, Section 15 and Appendix D, Table 14.

3020D DUCTWORK INSPECTION/SERVICING ACCESS OPENINGS:

- Provide access/inspection openings in accordance with BESA TR/19.

3030A METAL DUCTWORK TEST HOLES:

- Provide test holes in ductwork system, to allow complete testing and balancing of system in accordance with CIBSE Commissioning Code A.
- Site drill test holes in accordance with BESA DW/144.

3040 HOLES FOR CONTROLS/INSTRUMENTS - METAL DUCTWORK:

- Provide holes in ductwork, in accordance with BESA DW/144 to accommodate thermostats, humidistats and other control sensors in positions and sizes indicated on drawings.

3041 CONTROLS/SENSING EQUIPMENT - PLASTICS DUCTWORK:

- Install sensors and test points to suit specialist control and sensing equipment in positions and fixing configurations shown on drawings.

3042 INSTALLATION OF INSTRUMENTS AND CONTROLS:

- Instruments and controls should be installed to manufacturers or specialist supplier's requirements. The installation must be checked by the manufacturer or specialist supplier, and rectified as necessary.

3050A CLEANING ACCESS - BASIC LEVEL OF PDI:

- Provide access for cleaning in accordance with BESA documents DW/144 and TR/19.

3050B CLEANING ACCESS - INTERMEDIATE LEVEL OF PDI:

- Provide access for cleaning in accordance with BESA documents DW/144 and TR/19.

3050C CLEANING ACCESS - ADVANCED PDI WITH POST INSTALLATION CLEAN:

- Provide access for cleaning in accordance with BESA documents DW/144 and TR/19.
- The specialist cleaning contractor, in addition to taking advantage of openings fitted by the ductwork installer, shall supply and install any additional cleaning openings to suit their selected specific methods of cleaning and suit the practical site conditions relative to the fabric of the building and position of other services.

3060A STEEL SINGLE-BLADE BALANCING DAMPERS - METAL DUCTS:

- Provide single or double skin steel single blade balancing dampers in accordance with DW/144. Manual operation. Locations and size as shown on drawings and as required for balancing.
- Undertake aerodynamic testing of dampers in accordance with BS EN 1751.
- Where required, determination of sound power levels to be by measurement in a reverberation room in accordance with BS EN ISO 5135.

3060B STEEL MULTI-BLADE BALANCING DAMPERS - METAL DUCTS:

- Provide single or double skin steel multi-blade balancing dampers in accordance with DW/144. Parallel or opposed blade, manual operation. Locations and size as shown on drawings and as required for balancing.
- Undertake aerodynamic testing of dampers in accordance with BS EN 1751.
- Where required, determination of sound power levels to be by measurement in a reverberation room in accordance with BS EN ISO 5135.

3060C STEEL SINGLE-BLADE CONTROL DAMPERS - METAL DUCTS:

- Provide single or double skin steel single blade control dampers in accordance with DW/144. Locations and size as shown on drawings and as required for balancing.
- Aerodynamic testing of dampers in accordance with BS EN 1751.
- Where required, determination of sound power levels to be by measurement in a reverberation room in accordance with BS EN ISO 5135.

100.010 3060D STEEL MULTI-BLADE CONTROL DAMPERS - METAL DUCTS:

- Provide single or double skin steel multi-blade control dampers in accordance with DW/144. Parallel or opposed blade, automatic operation. Locations and size as shown on drawings and as required for balancing.
- Undertake aerodynamic testing of dampers in accordance with BS EN 1751.
- Where required, determination of sound power levels to be by measurement in a reverberation room in accordance with BS EN ISO 5135.

3060F STEEL BACK DRAUGHT REGULATING DAMPERS - METAL DUCTS:

- Provide regulating dampers in accordance with DW/144. Locations and size as shown on drawings and as required.
- Undertake aerodynamic testing of dampers in accordance with BS EN 1751.
- Where required, determination of sound power levels to be by measurement in a reverberation room in accordance with BS EN ISO 5135.

3070A STEEL CURTAIN FIRE DAMPERS - BLADES IN AIR STREAM:

- Supply and install steel folding curtain fire dampers, with blades partially in the air stream, in accordance with DW/144 and BS EN 15650, size and location as shown on the drawings and as required.
- Where required undertake aerodynamic testing of fire dampers in accordance with BS EN 1751.
- Fire-resistance tests of thermal release mechanism in accordance with BS ISO 10294-4.

3070B STAINLESS STEEL CURTAIN FIRE DAMPERS - BLADES IN AIR STREAM:

- Supply and install stainless steel folding curtain fire dampers, with blades partially in the air stream, in accordance with DW/144 and BS EN 15650, size and location as shown on the drawings and as required.
- Where required undertake aerodynamic testing of fire dampers in accordance with BS EN 1751.
- Fire-resistance tests of thermal release mechanism in accordance with BS ISO 10294-4.

3070E STEEL SINGLE BLADE FIRE DAMPERS:

- Supply and install steel single blade fire dampers in accordance with DW/144 and BS EN 15650, size and location as shown on the drawings and as required.
- Where required undertake aerodynamic testing of fire dampers in accordance with BS EN 1751.
- Fire-resistance tests of thermal release mechanism in accordance with BS ISO 10294-4.

3070F STAINLESS SINGLE BLADE FIRE DAMPERS:

- Supply and install stainless steel single blade fire dampers in accordance with DW/144 and BS EN 15650, size and location as shown on the drawings and as required.
- Where required undertake aerodynamic testing of fire dampers in accordance with BS EN 1751.
- Fire-resistance tests of thermal release mechanism in accordance with BS ISO 10294-4

3070G STEEL MULTI-BLADE FIRE DAMPERS:

- Supply and install steel multi-blade fire dampers in accordance with DW/144 and BS EN 15650, size and location as shown on the drawings.
- Where required undertake aerodynamic testing of fire dampers in accordance with BS EN 1751.
- Fire-resistance tests of thermal release mechanism in accordance with BS ISO 10294-4.

3070H STAINLESS STEEL MULTI-BLADE FIRE DAMPERS:

- Supply and install stainless steel multi-blade fire dampers in accordance with DW/144 and BS EN 15650, size and location as shown on the drawings and as required.
- Where required undertake aerodynamic testing of fire dampers in accordance with BS EN 1751.
- Fire-resistance tests of thermal release mechanism in accordance with BS ISO 10294-4.

3070I INTUMESCENT FIRE DAMPERS:

- Supply and install intumescent fire dampers in accordance with DW/144 and BS EN 15650, size and location as shown on the drawings and as required.
- Fire resistance tests for intumescent dampers shall be in accordance with BS ISO 10294-5

3070J FIRE DAMPERS ACCESSORIES:

- Provide accessories compatible with fire dampers. Electrical cut-out switches and external visual indication of fire damper blade position.
- Supply spare fusible links for fire dampers to fuse at 72ºC as specified in DW/144.

3071 FIRE STOPS - PLASTICS DUCTWORK:

- Supply and install fire dampers or intumescent sleeves in accordance with DW/154, Part 6, Section 17, size and location as shown on the drawings.

3075 FIRE DAMPERS - GENERAL:

- Types to be as identified elsewhere in the specification, in schedules or on drawings.
- Fire dampers shall be supplied and fixed in accordance with the manufacturer's recommendations and installation methods which conform to the prevailing Building Regulations (ADB) and are acceptable to the local Authorities Having Jurisdiction generally in accordance with DW/144 and DW/145 or DW/154. The proposed installation method must be supported by a valid test report or assessment provided by an approved third party notified body.
- The construction shall allow for all additional framing supports, bracing and fire stopping as may be necessary to adequately attach/install the fire dampers to the structure. The assembly is to be approved by the local Authorities Having Jurisdiction.
- Each fire damper and associated installation method shall have at least the same standard of fire integrity as the wall or floor through which the duct passes.
- Where required undertake aerodynamic testing of fire dampers in accordance with BS EN 1751.
- The classification of fire dampers is to be in accordance with BS EN 13501-3 and shall have an integrity classification 'E' to meet that of the wall or floor.

- When a fire integrity of 4 hours is required, either 2 dampers (classified E120) factory assembled in series (if acceptable to the Local Authority) or a single damper having a classification E240, may be used.
- To achieve these classifications, fire resistance tests shall be in accordance with BS EN 1366-2, undertaken by a notified body.
- Shutter dampers shall be provided with the shutter blades located outside the air stream (unless other wise indicated). Each damper shall have a stainless steel curtain in all-welded galvanized steel casing with stainless steel side seal gaskets. The damper blade curtain shall be held in the folded position by a dual safe thermal actuator and fusible link.
- All damper blades shall be tensioned to ensure instantaneous closure on thermal activation at 72°C (unless specified elsewhere). A self-latching reset mechanism shall be provided for easy re-setting of the damper curtain.
- On completion of the installation, the contractor shall be responsible for ensuring the inspection and testing of all fire dampers installed are carried out. Upon completion of the tests, the certificates must be issued for confirming that the dampers have been inspected and that they function correctly in accordance with the manufacturer's data sheets.
- Access panels with chains shall be provided adjacent to the access side of all fire dampers.
- In no instances shall flexible duct connections be allowed onto fire dampers through walls or floors. Approved flexible connectors for breakaway joints, or duct expansion in case of fire, may be used in association with fire dampers.
- Provide local external visual indication of fire damper blade position, unless indicated otherwise.

3079 SMOKE DAMPERS - GENERAL

- Types to be as identified elsewhere in the specification, in schedules or on drawings.
- Smoke dampers shall be supplied and fixed in accordance with the manufacturer's recommendations and installation methods with installation mounting frames which conform to the prevailing Building Regulations (ADB) and are acceptable to the local Authorities Having Jurisdiction and are generally in accordance with DW/144 and DW/145 or DW/154. The proposed installation method must be supported by a valid test report or assessment provided by an approved third party notified body.
- The construction shall allow for all additional framing supports, bracing and fire stopping as may be necessary to adequately attach/install the smoke dampers to the structure. The assembly is to be approved the local Authorities Having Jurisdiction.
- Where required undertake aerodynamic testing of fire dampers in accordance with BS EN 1751.
- The classification of smoke dampers is to be in accordance with the requirements of BS EN 13501-4 and fire-resistance tests shall be in accordance with BS EN 1366-10.
- Smoke control dampers placed on the market and intended to operate as part of a pressure differential system or smoke and heat control system to be in accordance with BS EN 12101-8.
- Smoke dampers shall be of the single blade or multi-blade type as indicated elsewhere in this specification. Damper blades shall be mechanically connected to an actuator to hold the blades in either the open or closed position dependent on the control mode chosen.
- On completion of the installation, the contractor shall be responsible for ensuring the inspection and testing of all smoke dampers installed are carried out. Upon completion of the tests, the certificates must be issued for confirming that the dampers have been inspected and that they function correctly in accordance with the manufacturer's data sheets.
- Access panels with chains shall be provided adjacent to the access side of all smoke dampers (additional access may be required for cleaning purposes and should be supplied if necessary).
- In no instances shall flexible duct connections be allowed through walls or floors. Approved flexible connectors from breakaway joints, or duct expansion in case of fire, may be used in association with smoke dampers.

- Provide local external visual indication of smoke damper blade position, unless indicated otherwise.

3080# SMOKE DAMPERS:

- Supply and install smoke dampers in accordance with DW/144, size and location as shown on the drawings and as required.
- Material
  - Steel.

3089 COMBINATION FIRE AND SMOKE DAMPERS - GENERAL:

- Types to be as identified elsewhere in the specification, in schedules or on drawings and as required.
- Combination smoke and fire dampers shall be supplied and fixed in accordance with the manufacturer's recommendations and installation methods which conform to the prevailing Building Regulations (ADB) and are acceptable to the local Authorities Having Jurisdiction generally in accordance with DW/144 and DW/145 or DW/154. The proposed installation method must be supported by a valid test report or assessment provided by an approved third party notified body.
- The construction shall allow for all additional framing supports, bracing and fire stopping as may be necessary to adequately attach/install the fire dampers to the structure. The assembly is to be approved by the local Authorities Having Jurisdiction.
- Each combination smoke and fire damper and associated installation method shall have at least the same standard of fire integrity as the wall or floor through which the duct passes.
- Where required undertake aerodynamic testing of fire dampers in accordance with BS EN 1751.
- The classification of combination fire and smoke dampers is to be in accordance with BS EN 13501-4 and shall have an integrity classification 'E' to meet that of the wall or floor supported with an 'ES' classification of at least 60 minutes, unless the wall or floor requires less than this (e.g. 30 minutes).
- When a fire integrity of 4 hours is required, either 2 dampers (classified E120, ES60 (min) factory assembled in series (if acceptable to the Local Authority) or a single damper having a classification E240, ES60 (min)), may be used.
- To achieve these classifications, fire resistance tests shall be in accordance with BS EN 1366-2 and BS EN 1366-10, undertaken by a notified body.
- Combination fire and smoke dampers tested ad-hoc to BS 476-20 and BS 476-22 shall be permitted only under conditions where the Building Regulations (ADB) specifically allow. This requirement shall be confirmed before supplying such tested product.
- Combination smoke and fire dampers shall be of the single blade or multi blade type as indicated elsewhere in this specification. Damper blades shall be released from their open position by means of either a thermal release device rated at a temperature indicated elsewhere in this specification, or via a mechanical actuator connected to a smoke alarm or control system, or a combination of both dependent on the control mode selected.
- On completion of the installation, the contractor shall be responsible for ensuring the inspection and testing of all combination smoke and fire dampers installed are carried out. Upon completion of the tests, the certificates must be issued for confirming that the dampers have been inspected and that they function correctly in accordance with the manufacturer's data sheets.
- Access panels with chains shall be provided adjacent to the access side of all combination smoke and fire dampers.

- In no instances shall flexible duct connections be allowed through walls or floors. Approved flexible connectors for breakaway joints, or duct expansion in case of fire, may be used in association with combination smoke and fire dampers.
- Provide local external visual indication of combination smoke and fire damper blade position, unless indicated otherwise.

3090# COMBINATION SMOKE AND FIRE DAMPERS:

- Supply and install smoke and fire dampers in accordance with DW/144 and BS EN 15650, size and location as shown on the drawings and as required.
- Where required undertake aerodynamic testing of fire dampers in accordance with BS EN 1751.
- Fire-resistance tests of thermal release mechanism in accordance with BS ISO 10294-4.
- Material
    - Steel.

3100A COATED STEEL FLEXIBLE DUCTS:

- Supply and fasten coated steel flexible duct connections as DW/144. Use flexible duct connections in applications listed in DW/144.
- Comply with BS EN 13180 and provide a test certificate proving compliance with the mechanical characteristics of this standard.
- Ductwork and insulation to have a test certificate proving reaction to fire performance requirements of BS 9999. Materials to conform to Euroclass A1 as specified in BS EN 13501 or when tested to BS 476-6 has a fire propagation index of not more than 12 and a sub-index of not more than 6.
- Maximum length 600mm.

3100B ALUMINIUM FLEXIBLE DUCTS:

- Supply and fasten aluminium flexible duct connections as DW/144. Use flexible duct connections in applications listed in DW/144.
- Comply with BS EN 13180 and provide a test certificate proving compliance with the mechanical characteristics of this standard.
- Ductwork and insulation to have a test certificate proving reaction to fire performance requirements of BS 9999. Materials to conform to Euroclass A1 as specified in BS EN 13501 or when tested to BS 476-6 has a fire propagation index of not more than 12 and a sub-index of not more than 6.
- Maximum length 600mm.

3110A FLEXIBLE JOINT CONNECTIONS:

- Supply and install flexible joint connections as detailed in DW/144 or DW/154 Section 18, as appropriate.
- Use flexible joints, as shown on drawings; on fan inlet/outlets; and on building expansion joints.
- All flexible joint connections shall comply with current Building Regulations regarding the spread of fire and smoke.

3120A BIRD WIRE GUARDS:

- Fit bird screens of 13mm square mesh wire on all intake and extract louvres to atmosphere. Wire gauge to be not less than 1mm.
- Finish - Plastic coated wire.

3130A INSECT GUARDS:

- Provide manufacturer's standard insect guards where indicated. Screens to be factory fitted by the manufacturer.
    - Material: Woven wire cloth.
    - Mesh: 16.
    - Gauge: 28.
    - Wire diameter: 0.375 mm.
    - Aperture: 1.212 mm^2.
    - Free area: 58%.

3130B INSECT GUARDS:

- Provide insect guards where indicated. Screens to be supplied in kit form for installation on-site.
    - Material: Black PVC coated glass fibre mesh.
    - Aperture size: 1.1 x 1.55 mm.
    - Weight: 155 g/m^2.
    - Free area: 62%.

4000 WORKMANSHIP

4010 GENERAL WORKMANSHIP:

- Install ductwork in accordance with DW/144, DW/154 and DW/191 as appropriate.
- Ensure that there are no sharp edges or corners on cut edges on ductwork, flanges and supports.
- Install pre-insulated ductwork to BS EN 13403 in accordance with manufacturer's instructions.

4015 FLEXIBLE DUCTWORK INSTALLATION:

- Comply with BSRIA Guide BG43. Flexible ductwork.
- Minimum radius ratio (R/D) to be not less than 2, where R is the centre line radius and D is the duct diameter.
- Maximum support interval – 600mm.
- Support rings to be sized so as not to constrict the cross-sectional area of the ductwork.
- Duct support ring minimum width – 25mm.
- Flexible ducts to overlap rigid duct or terminal device spigot by a minimum of 50mm.
- Make a seal between flexible duct and rigid connection using mastic sealant or duct tape
- Use a mechanical fixing for connection using a duct band.

4020 DUCTWORK SUPPORTS:

- Support ductwork in accordance with DW/144; DW/154 Part 5; or DW/191 Section 7 as appropriate. Install supports to ensure insulation can be applied unless otherwise indicated.

4025 COMPONENT SUPPORT ON PRE-INSULATED ALUMINIUM DUCTWORK:

- Support ducts with dimensions less than 1m at intervals of no more than 4m. Support ducts with dimensions over 1m at intervals of no more than 2m.
- Provide independent support for all accessories.

4030A DUCT SUPPORT FOR VAPOUR SEAL CONTINUITY:

- Where a vapour seal is required, use method of support detailed on drawing as indicated.

4040 EXTERNAL DUCTWORK SUPPORTS:

- Support ductwork external to building as indicated.
- Comply with BESA DW/144 Section 26.
- All supports shall either be constructed from mild steel structural sections and galvanised after manufacture or fabricated using a proprietary support system / support feet to assist in spreading the weight on a roof membrane. Submit proposals to Designer and Structural Engineer for comment.
- Particular care should be taken in selecting structural fixings that will provide a life cycle appropriate to the buildings intended use. All supports and fixings shall comply with Local Authority requirements. Obtain approval from the Local Authority where required.

4050 DUCTWORK FLOOR SUPPORT:

- Support ductwork from floor as indicated.

4060 DRAINAGE OF DUCTWORK:

- Arrange ductwork to drain any entrained moisture and ensure the lapping of joints minimises moisture leakage.

4090A INTERNAL CLEANLINESS - BASIC LEVEL:

- Provide Basic Level of protection, delivery and installation (PDI) as defined in BESA TR/19.

4090B INTERNAL CLEANLINESS - INTERMEDIATE LEVEL:

- Provide Intermediate Level of protection, delivery and installation as defined in BESA TR/19.

4090C INTERNAL CLEANLINESS - ADVANCED LEVEL:

- Provide Advanced Level of protection, delivery and installation as defined in BESA TR/19

4090D DRY METHOD OF CLEANING:

- The specialist cleaning contractor shall select and propose for approval the most appropriate cleaning method from table 8 in BESA TR/19.

4090E WET METHOD OF CLEANING:

- The specialist cleaning contractor shall select and propose for approval the most appropriate cleaning method from table 8 in BESA TR/19.
- The system should be thoroughly dried prior to commissioning/de-commissioning to prevent moisture assisting in the growth of micro-organisms.
- A risk assessment must be carried out before any cleaning chemicals or biocides are considered. The details of any such chemicals or biocides must be recorded and any adverse effects of the applied chemicals assessed and determined, with appropriate safe procedures set out in a formal method statement.
- Steam cleaning and high pressure water wash are not recommended for ductwork that is situated above ceilings or in sensitive areas unless carried out in a controlled manner to contain leakage. Procedures to take account of operative safety must be adopted, and should be set out in written form.
- Careful consideration should be given to the use of chemicals and/or water for surfaces that are porous e.g. internally-lined ductwork, attenuators, fibre board ductwork, attenuators, fibre board ductwork etc., to prevent permanent damage.
- Before applying wet cleaning methods care should be taken that condensed vapours and cleaning fluids can be removed from the ductwork system.

4100A WEATHERPROOFING:

- Fit ductwork with trimming angle and weather cravat, skirt, flashing plate and cowl where ductwork passes through or terminates in roof, to ensure a weatherproof seal to building structure, as indicated.

4110A DUCTWORK SLEEVES:

- Where indicated, enclose ducts passing through building elements, (walls, floors, partitions, etc.) within purpose made sleeves. Cut sleeves of the same material as the duct and pack with mineral fibre or similar non-flammable and fire resistant material to form a fire/smoke stop of adequate rating and to prevent air movement and noise transmission between duct and sleeve.
- Where finished insulation is carried through duct sleeves. Pack space between insulation finish and sleeve with non-flammable and fire resistant material to form fire stop.

4110B DUCTWORK SLEEVES WITH FLANGES:

- Where indicated, enclose ducts passing through building elements, (walls, floors, partitions, etc.) within purpose made sleeves. Cut sleeves of the same material as the duct and pack with mineral fibre or similar non-flammable and fire resistant material to form a fire/smoke stop of adequate rating and to prevent air movement and noise transmission between duct and sleeve.
- Provide flanges on either side of wall where ductwork is exposed in rooms.
- Where finished insulation is carried through duct sleeves. Pack space between insulation finish and sleeve with non-flammable and fire resistant material to form fire stop.

4130 INSTALLATION OF CONTROL EQUIPMENT:

- Fit sensors, damper motors and other control equipment as indicated.
- All control equipment should be installed to manufacturer or specialist supplier's requirements. The installation must be checked by the manufacturer or specialist supplier, and rectified as necessary.

4140 INSTRUMENT CONNECTIONS:

- Provide instrument connections where indicated.
- All instrument connections should be installed to manufacturer or specialist supplier's requirements. The installation must be checked by the manufacturer or specialist supplier, and rectified as necessary.

4160 DAMPER ACCESS:

- Ensure access is provided to damper mechanisms on fire dampers; smoke dampers; combined smoke and fire dampers; and volume control dampers through access doors, false ceilings etc..
- Demonstrate that damper blades close completely.
- Demonstrate that fire links can be replaced. Where more than one fire damper is installed in a frame ensure access is provided to all fire dampers.

Y40 - AIR HANDLING UNITS

1000 GENERAL:

- Comply with BS EN 1886 for mechanical performance of air handling units as a whole. Refer to particular specification or schedules for casing strength, air leakage, thermal transmittance and thermal bridging classifications and general acoustics performance requirements.
- Comply with BS EN 13053 for testing for ratings and performance of air handling units as a whole and components and sections within units.

1001 GENERAL - HEALTHCARE BUILDINGS:

- Comply with HTM 03-01. Should there be a conflict between this document and clauses in this specification HTM 03-01 shall take precedence.

1010B CASING AIR LEAKAGE:

- Ensure air-handling unit is sealed to minimize air leakage at design pressure.
- AHU leakage rate shall not exceed the maximum rate defined in BS EN 1886 for the leakage class of casing scheduled or detailed in the particular specification.
- Test pressure - 400Pa negative and 700Pa positive.

1010C FILTER BYPASS LEAKAGE:

- Filter bypass leakage, at 400Pa test pressure, shall not exceed the acceptable maximum % of volume flow rate defined in BS EN 1886 for the class of filter scheduled or detailed in the particular specification.

1020 FAN SELECTION:

- Air volume - Ensure scheduled volume is provided when operating against resistance of system corrected for changes between specified and selected component resistance.
- System resistance - Adjust scheduled resistance to compensate for actual resistance of selected components.
- Operating point
    - Select operating point on pressure/volume curve to provide stable and efficient operation.
    - Whenever possible the fan supplier shall select fans over the range of air flows where the efficiency is not less than 85% of the optimum efficiency in accordance with Annex E in BS EN ISO 12759
- Fans driven by electric motors with electric input between 125W and 500kW to comply with EU Regulation 327/2011 with regard to eco-design requirements.
- Guaranteed performance
    - Provide fan performance figures in accordance with
    - BS EN ISO 5801
    - BS 848-9

2000 PRODUCTS/MATERIALS

2020# DOUBLE SKIN CASING AIR HANDLING UNITS:

- Panel skin thickness - 0.8 mm as a minimum
- External casing finish - Pre-painted as per manufacturer's standard.
- Internal casing finish - Pre-painted as per manufacturer's standard.

2030# AIR HANDLING UNIT CONSTRUCTION:

- General construction

- Construct unit to withstand maximum fan static pressure without plastic deformation.
- Construct casing from panels, thickness as indicated.
- Ensure panels do not deflect by more than the values given in BS EN 1886 when in operation and withstand maximum fan pressure at design fan speed. No permanent deformation (hysteresis maximum +/- 2.0 mm per m frame/panel span) of the structural parts (structures and supports) or damage of the casing may occur.
    - Casing strength Class D1 - 4 mm/m maximum relative deflection.
- Use corrosion resistant fastenings throughout.
- Do not use self-tapping screws.
- Provide panel gaskets to give a durable seal between panels and frames to prevent excessive air leakage.
- Ensure unit satisfies the fire protection criteria given in BS EN 1886.
- Ensure unit satisfies the mechanical safety criteria given in BS EN 1886.

- Casing thermal performance
    - Ensure the casing thermal performance is tested in accordance with the requirements of BS EN 1886
    - Thermal transmittance U of the casing shall be classified in accordance with BS EN 1886
        - Thermal transmittance Class T2 - greater than 0.5 up to 1.0
    - Thermal bridging factors kb shall be classified in accordance with BS EN 1886
        - Thermal bridging factor Class TB2 - greater than 0.6 but less than 0.75
- Casing acoustic performance - Ensure that the sound insertion loss of the unit is determined in accordance with BS EN 1886
- Casing Insulation
    - Ensure insulation complies with BS 476-7. Ensure insulation is fixed securely to panel, and protected to prevent migration of fibre into air flow.
    - Ensure insulation is vapour sealed throughout and incorporate thermal breaks.
    - Insulation material - Provide insulation that is inorganic, vermin proof and non-hygroscopic
    - Use CFC free rigid polyurethane foam, minimum of 25 mm thick or CFC free injected polyurethane foam, minimum 25 mm thick.
- Framework
    - Ensure framework is rigid enough to prevent distortion during transportation and after final assembly on-site.
    - For vertical units strengthen framework to support additional weight.
    - Seat panels into folded, rolled or extruded frame with purpose made corner joints; or pentapost type frame with purpose made corner joints.
    - Ensure framework is self-supporting.
- Base - Provide rolled steel channel (RSC) support base.

2040A AIR HANDLING UNIT ACCESS:

- Provide access openings and covers complete with opening devices, and sealed to prevent air leakage.
- Ensure seals are designed for normal maintenance operations for a minimum of 10 years.
- Provide hinged access doors, 400mm minimum width.
- Operating device - key operated door locks.
- Provide access to fans, dampers, filters, spray coils, humidifiers and within air handling unit for inspection of nozzles and tanks.

2040B PERMANENT ACCESS PLATFORMS - DOUBLE DECK AHU'S:

- For double deck AHU's design, supply and install permanent maintenance access platforms where the top of the upper deck is 3 m above FFL of general access area.
- Where possible support from the AHU base frame to minimise support legs to FFL.
- Provide handrails and toeboard / kick plate on all open sides of the platform, toeboard height - 100mm.
- Provide access stair(s) for frequent maintenance access to change filters and maintain fans etc.
- Clear width of platform shall be no less than 1.1m wide.
- Details and extent of platform - as indicated on drawings and / or schedules.
- Comply with Work at Height Regulations 2005 and relevant parts of BS EN ISO 14122.
- Materials - galvanised steel, with open mesh flooring.

2060A EXTERNAL AIR HANDLING UNITS:

- Construct air-handling units for external use. Provide weatherproof isolators.
- Roof construction as indicated on drawings.
- Options - Where indicated provide connection for Lightning protection.

3000 ACCESSORIES/COMPONENTS

3010# FAN SECTION:

- Provide frame for motor and fan and comply with fire regulations.
- Ensure frame is isolated from casing.
- For blow through units, ensure air flow in downstream sections of unit have relatively uniform velocity profile.
- Supply fan guards to BS EN ISO 12100 and BS EN ISO 12499
- Accessories
    - Provide flexible connection between fan discharge and casing spigot. Ensure flexible connections comply with fire regulations.
    - Provide manometer connections to measure static pressure at fan inlet eye.
    - Provide manometer connections to measure static pressure at fan discharge.

3030 HEATER BATTERIES:

- Provide slide rails to allow each coil section to be removed independently for access.
- Fit baffle plates to prevent air bypass of coil.
- Coils to be rated in accordance with BS EN 1216
- Frost coils to be constructed of plain tubing without fins unless specified otherwise in the particular specification.
- All hot water frost coils on healthcare projects to use bare tubing. Steam coils on healthcare projects may use finned tube with wide fin spacing approved by the design engineer.

3040 COOLING COIL SECTION:

- Provide slide rails to allow each coil section to be removed independently for access.
- Coils to be rated in accordance with BS EN 1216
- Water shall not be carried over from the cooler into the air stream.
- Incorporate drip trays with drains to both coil and headers.

3042 HEAT RECOVERY EQUIPMENT:

- Thermal wheel
    - Units to be performance tested in accordance with BS EN 308 using the relevant testing protocol of Eurovent or AHRI Standard 1060. Units to be complete with a purge sector.

3050 DRAINAGE FROM AIR HANDLING UNIT COMPONENTS:

- Provide drainage pipework from cooling coils, humidifiers and components where water may collect. Comply with recommendations in CIBSE Technical Memorandum TM13 in connection with Legionnaires' disease and AHU manufacturers' installation recommendations.
- Material - glass drainage system unless specified otherwise in the particular specification.
- Pipe each trap to drain via a tun-dish or pipe each trap separately to discharge over a gully to prevent the potential of cross contamination between AHU's.
- Label each trap to state that it must be checked regularly / kept topped-up.
- Where freezing could occur insulate and trace-heat traps.

3060# CONTROL DAMPERS:

- Provide control dampers in accordance with DW/144.
- Type of air control damper
    - For single-blade damper
        - Operation: Automatic
    - For skin multi-blade damper
        - Opposed blade.
        - Operation: Automatic
- Construction
    - Material - Steel.
- Ancillaries
    - Position indicator.
    - Locking device.
- Motorized control dampers
    - Provide control dampers complete with
        - Extended spindle.
        - Motor.
        - Motor linkage.
        - Motor support.

4000 WORKMANSHIP

4040 DUCT CONNECTIONS:

- Ensure air is straightened as it leaves unit discharge. Ensure ductwork connection is long enough to ensure the aerodynamic performance of the fan is not affected.

4050 SERVICES CONNECTIONS:

- Ensure panels are sealed around electrical cable and pipework service entry points to prevent air leakage, using suitable and approved methods to suit individual services applications.
- Provide flexible cables between fan motor and local isolator.

4060 ISOLATION OF UNITS:

- Provide means of isolating air-handling units electrically to allow maintenance and repairs to be carried out.
- Provide means of isolating pipework to air handling units to allow maintenance and repairs to be carried out.
- Provide means of isolating steam to humidifier when access door is opened.

4070 DRAINAGE OF FREE WATER:

- Make provision for free water to be caught, collected and drained away. Provide U-traps on all drains suitable for the negative/positive pressure created by the fan.

4090# FACTORY TESTS:

- Carry out tests at the factory to measure the following.
  - Fan running to check rotation and vibration.
  - Fan and motor speeds.
  - Ratings and Performance to BS EN 13053
    - Whole unit.
    - Fan section.
    - Coils.
    - Heat recovery sections.
    - Damper sections.
    - Mixing sections.
    - Humidifiers.
    - Filter sections.
    - Sound attenuation sections.
  - Mechanical performance to BS EN 1886.
    - Air leakage test.
    - Filter bypass leakage test.
    - Mechanical strength of casing test (Casing panel deflection).
    - Thermal transmittance performance test.
    - Thermal bridging test.
    - Acoustic insulation test (Casing insertion loss test).
  - Air flow performance test in accordance with BS 6583.
  - Motor starting, running currents and inverter settings.
  - Fan flow rate and developed pressure, using simulated system resistance.
  - Component air pressure drops.
  - Component water pressure drops.
  - Fan sound power levels.
  - External sound pressure level tests unit under conditions of unobstructed propagation over base surfaces.
  - Vibration measurements.
  - Functional tests on electrical equipment.
  - Functional tests on controls systems if provided as part of the AHU.
  - Component functional tests.
  - Power consumption.

4100# TESTING PRIOR TO INCORPORATION IN WORKS:

- Carry out testing to measure the following.
  - Ratings and Performance to BS EN 13053
    - Whole unit.
    - Fan section.
    - Coils.
    - Heat recovery sections.
    - Damper sections.
    - Mixing sections.

    - Humidifiers.
    - Filter sections.
    - Sound attenuation sections.
- Mechanical performance to BS EN 1886.
    - Air leakage test.
    - Filter bypass leakage test.
    - Mechanical strength of casing test (Casing panel deflection).
    - Thermal transmittance test.
    - Thermal bridging test.
- Fan running to check rotation and vibration.
- Acoustic insulation test (casing insertion loss test).
- Fan and motor speeds.
- Air flow performance test in accordance with BS 6583.
- Motor starting running currents and inverter settings.
- Fan flow rate and developed pressure, using simulated system resistance.
- Component air pressure drops.
- Component water pressure drops.
- External sound pressure level tests under conditions of unobstructed propagation over base surfaces.
- Vibration measurements.
- Functional tests on electrical equipment.
- Functional tests on controls systems if provided as part of the AHU.
- Power consumption.
- In duct fan sound power levels.

Y41 - FANS

1000 GENERAL:

- Standards
    - Provide fans manufactured and tested in accordance with appropriate European Standards.
    - With regard to safety requirements, comply with BS EN 60335-2-80 where applicable.
    - Fans for smoke and heat control to be in accordance with BS EN 12101-3
    - Fans for use in potentially explosive atmospheres / flameproof zones to be in accordance with BS EN 14986, relevant parts of BS EN ISO 80079, BS EN 13463 and BS EN 60079, and be compliant with the ATEX directive.
    - Inline and chimney outlet exhaust fans to comply with BS EN 16475-2

1010 DESIGN DUTIES, FAN SELECTION AND EFFICIENCY:

- Air volume - Ensure scheduled volume is provided when operating against resistance of system corrected for changes between specified and selected component resistance.
- System resistance - Adjust scheduled resistance to compensate for actual resistance of selected components.
- Operating point
    - Select operating point on pressure/volume curve to provide stable and efficient operation.
    - Whenever possible the fan supplier shall select fans over the range of air flows where the efficiency is not less than 85% of the optimum efficiency in accordance with Annex E in BS EN ISO 12759
- Fans driven by electric motors with electric input between 125W and 500kW to comply with EU Regulation 327/2011 with regard to ecodesign requirements.
- Comply with EU Regulation 1253/2014 for packaged ventilation units comprising fan(s), heat recovery system, filters and controls (or a combination of these components) up to 1000m^3/hr with regard to ecodesign requirements.
- Guaranteed performance
    - Provide fan performance figures in accordance with
    - BS EN ISO 5801 for all types except those designed solely for air circulation.
    - BS 848-9 for tolerances, methods of conversion and technical data presentation.

1020 PROTECTION:

- Protect casings, impellers and shafts against corrosion.
- Protect bearings against dirt and moisture.

2000 PRODUCTS/MATERIALS

2010A NORMAL OPERATING CONDITIONS:

- Sound Power Level
    - Select fan, motor, drive and speed control system not to exceed fan sound power levels or sound pressure levels scheduled or specified elsewhere. Provide sound power data in accordance with BS EN ISO 5136, BS ISO 13347-1, BS ISO 13347-2, BS ISO 13347-3, BS ISO 13347-4.
- Air Density - Relate fan performance to air density 1.20kg/m^3.
- Temperature Range
    - Minimum to maximum operating temperatures -20°C to 60°C.

2010B POTENTIALLY EXPLOSIVE ATMOSPHERES

- Constructional requirements
  - The constructional requirements for fans intended for use in explosive atmospheres shall be in accordance with BS EN 14986 and relevant parts of BS EN 60079 and BS EN 80079.
    - Ambient atmosphere pressure:
    - Absolute pressure ranging from 0.8bar to 1.1bar.
  - Temperature range
    - Minimum to maximum operating temperatures of -20°C to 60°C inlet gas temperature, -10% to +20% of nominal gas flow.

2020A CONSTRUCTION AND HANDLING:

- Casings
  - Construct rigid casing free from drumming under operating conditions. Supply in sections as required for access or handling. Flange dimensions in accordance with BS EN ISO 13351.
- Safety standards - to BS EN 60335-2-80.
- Rotating assemblies
  - Balance rotor in accordance with relevant parts of BS ISO 21940
- Shafts and hubs
  - Machine impeller bosses and shafts to BS 4500 and key in accordance with BS 4235-1. Hold impeller to shaft with set screw or taper lock fitting.
- Shaft bearings - Sealed for life.
- Drives and guards
  - Provide guards over shaft, couplings and rope in accordance with BS EN ISO 12100 and Factory Inspectorate requirements.
- Lifting
  - Provide lifting eyebolts or similar facilities on fans or sections heavier than 20kg.

2030 TESTING:

- Provide results of aerodynamic performance tests in accordance with BS EN ISO 5801
- Provide results of sound power tests in accordance with BS ISO 13347-1, BS ISO 13347-2, BS ISO 13347-3, BS ISO 13347-4, and/or BS EN ISO 5136 as appropriate to the application.
- Provide fan vibration measurements in accordance with BS ISO 14695
- Provide balancing and vibration measurements in accordance with BS ISO 14695
- The minimum energy efficiency requirements for fans driven by electric motors with electric input between 125W and 500kW should comply with EC Regulation 327/2011.

2070# AXIAL FLOW FANS:

- Fan impeller and casing aerodynamic efficiency
  - Manufacturer's standard to achieve overall efficiency of the fan, motor and drive combination scheduled or detailed elsewhere in the project particular specification.
- Bearings
  - Provide bearings suitable for mounting and direction of flow indicated.

2080# CENTRIFUGAL FANS:

- Fan impeller and casing aerodynamic efficiency
    - Manufacturer's standard to achieve overall efficiency of the fan, motor and drive combination scheduled or detailed elsewhere in the project particular specification.
- Operation - Single.
- Impeller Design
    - Supply fan with impeller to suit operating conditions.
- Mounting - Channel frame.
- Drain - fit drain connection at lowest point of scroll.

2090A PROPELLER FANS:

- Fan impeller and casing aerodynamic efficiency
    - Manufacturer's standard to achieve overall efficiency of the fan, motor and drive combination scheduled or detailed elsewhere in the project particular specification.
- Drives
    - When motor spindle is extended for mounting blade hub, connect motor to casing, diaphragm plate or mounting ring with support arms.
- Impellers
    - Supply profile blades designed to give uniform airflow.
- Mountings
    - Support fans on plate with circular opening sized and located in accordance with fan manufacturer's requirements.

2100A MIXED FLOW FANS:

- Fan impeller and casing aerodynamic efficiency
    - Manufacturer's standard to achieve overall efficiency of the fan, motor and drive combination scheduled or detailed elsewhere in the project particular specification.
- Operation - single.
- Provide bearings suitable for mounting and position as indicated on drawings.

2110# ROOF MOUNTED FANS:

- Fan impeller and casing aerodynamic efficiency
    - Manufacturer's standard to achieve overall efficiency of the fan, motor and drive combination scheduled or detailed elsewhere in the project particular specification.
- Vertical or horizontal discharge as shown on drawings.

3000 ACCESSORIES

3010 INSPECTION DOORS - AXIAL FANS:

- Fit air-tight inspection doors giving access to drive motors and other components requiring regular servicing or maintenance.

3020 INSPECTION DOORS - CENTRIFUGAL FANS:

- Fit air-tight doors in scroll and cover.

3030 INSPECTION DOORS - PROPELLER FANS:

- For diaphragm mounted fans fit an air-tight inspection door positioned to give access to drive, or other sub-components requiring regular servicing or maintenance.

3050A GUARDS:

- Provide guards in accordance with BS EN ISO 12100.
- Fit safety guards on air inlet and air outlet connections where these are freely accessible to personnel in accordance with BS EN ISO 12499.
- Provide bird guards where indicated.

3110 AIR FLOW SENSORS:

- Fit air flow sensors or pressure switches on twin fan units to sense fan failure and provide automatic changeover to standby fan.

4000 WORKMANSHIP

4010 LOCATION:

- Install fans in positions indicated, in accordance with manufacturer's instructions and recommendations in CIBSE TM42 - Fan Application Guide.

4020 ATTITUDE:

- Mount impeller shaft horizontally unless otherwise indicated.

4030 ALIGNMENT:

- Ensure fan is installed aligned to allow optimum air flow path.

4040 TESTING:

- Ensure fan is isolated from installation during air leakage testing of ductwork.

4050 DRAIN CONNECTION:

- Fit trap to drain connection at lowest point of scroll on centrifugal fans where indicated.

Y42 - AIR FILTRATION

1010 PRESSURE LOSS DATA:

- Provide pressure data as initial pressure loss at rated airflow and recommended final pressure loss.

1020 AIR FLOW THROUGH MEDIA:

- Provide filter media surface of area and layout to achieve optimum air velocity through media.

1030 SEALS:

- Provide filters with edge seals as appropriate to prevent air bypassing. Ensure seals remain effective after removal and replacement of cells.

2000 PRODUCTS/MATERIALS

2010A CASINGS WITH BOLTS, NUTS AND WASHERS FIXING:

- Ensure casings are robust to prevent distortion. Drill steel section end frames for bolts, nuts and washers, and rivets.

2010B CASINGS WITH CAPTIVE NUTS OR TAPPED HOLES FIXING:

- Ensure casings are robust to prevent distortion. Drill steel section end frames for captive nuts or tapped holes.

2010C CASINGS WITH CLIPS:

- Ensure casings are robust to prevent distortion. Drill steel section end frames for clips.

2020# FILTER TESTING:

- Test filters in accordance with
    - BS EN ISO 16890-2. Measurement of fractional efficiency and air flow resistance.
    - BS EN ISO 16890-3. Determination of gravimetric efficiency and air flow resistance versus mass of test dust captured.
    - BS EN ISO 16890-4. Conditioning method to determine the minimum fractional test efficiency.
    - BS EN 1822-1 High efficiency filters, classification, performance testing & marking.
    - BS EN 1822-2 High efficiency filters, aerosol production, measuring equipment & particle counting statistics.
    - BS EN 1822-3 High efficiency filters, testing flat sheet filter media.
    - BS EN 1822-4 High efficiency filters, determining leakage of filter elements.
    - BS EN 1822-5 High efficiency filters, determining the efficiency of filter elements.
    - BS EN ISO 10121-2 Test method for assessing the performance of gas-phase air cleaning media / devices.

2040# PANEL FILTERS:

- Ensure filter media is retained in frame.
- Provide disposable filter media of glass fibre with scrim or composite fibre material.

2050A BAG FILTERS:

- Ensure media retains its shape during full airflow conditions.
- Material - Provide synthetic or micro-fine glass fibre with reinforced backing mat.

- Supply holding frame from material suitable for application complete with sealing gasket located in holding frame.

2070C EFFICIENT PARTICULATE AIR (EPA) FILTERS :

- Standard
  - BS EN 1822-1
  - BS EN 1822-2
  - BS EN 1822-3
  - BS EN 1822-4
  - BS EN 1822-5
- Filter media - efficient filter media EPA.
- Filter casing with fitted gasket - stainless steel
- Filter testing
  - Test each EPA cell to relevant parts of BS EN 1822 and mark on a plate/label fixed to filter casing.

2080A ACTIVATED CARBON FILTERS:

- Provide absorbent bed filled with uniform thickness of activated carbon granules constructed to prevent settlement and pinholing.
- Media type - disposable or reactivated as indicated.
- Casing - Supply casing with removable panels, manufactured from mild steel with epoxy resin finish.

2090A ELECTROSTATIC PRECIPITATORS

- Supply electrostatic agglomerator with bag-type collector section. Fabricate casing from material suitable for application.
- Components
  - Supply assembly including perforated baffle or grid; ionizer section; collector section; and wash plant unit including hot water storage, pump, distribution pipework, spray nozzles and drain system, installed in casing.
  - Provide electrical control panel including all controls pre-wired.
- Safety
  - Provide fail-safe interlocks on control panel door.
  - Provide interlock to prevent washdown whilst precipitator is energized.
  - Provide clear indication of high voltage danger.

3000 ACCESSORIES

3010A PRESSURE GAUGE, DIAL TYPE :

- Dial type differential pressure gauge. Clearly mark gauge with positions equivalent to "Filter Dirty" and "Filter Clean" conditions.
- Connect gauge to duct mounting with PVC tubing. Fix external to unit to allow easy observation. Mount within 3m of filter.

3010B PRESSURE GAUGE, INCLINED MANOMETER:

- Inclined manometer type differential pressure gauge. Clearly mark scale with positions equivalent to "Filter Dirty" and "Filter Clean" conditions. Connect gauge to duct mounting with PVC tubing. Fix external to unit to allow easy observation. Mount within 3m of filter.

3010C PRESSURE GAUGE, PRESSURE DIFFERENTIAL SWITCH:

- Pressure differential switch for visual or audio warning of "Filter Blocked Condition".

3030A TERMINAL FILTER HOUSING, GASKET SEALS:

- Supply terminal filter housing for EPA, HEPA and ULPA filters.
- Housing seals
    - Provide gaskets to seal between holding frames on banks of filters.

3030B TERMINAL FILTER HOUSING, STEEL FRAME WITH EPOXY RESIN SEAL:

- Supply terminal filter housing for EPA, HEPA and ULPA filters.
- Housing seals
    - Seal filter into rigid epoxy resin finished steel casing with hard setting synthetic resin cement.

3040# SAFE CHANGE FILTER CHANGING UNIT:

- Supply purpose built unit for changing high efficiency filters in areas where special regulations are enforced.

4000 WORKMANSHIP

4020A ACCESS FOR MAINTENANCE:

- Provide access for changing filter media. Provide access for maintenance of motor drive and associated control equipment without disturbing filter media. Provide access for total duct maintenance.

Y43 - COILS, HEAT RECOVERY EQUIPMENT AND GAS AND ELECTRIC BATTERIES

2000 PRODUCTS/MATERIALS

2010# HEATING/COOLING COILS:

- Casing
  - Make provision for coil expansion. Enclose body of coil, headers and bends within casing.
  - Provide plugs in headers to permit internal cleaning of coils.
- Draining and venting
  - Provide plugged connections in headers to allow fitting of drain cocks / air vents.
  - Provide coil complete with venting and draining devices.
- Arrangement - Supply fins in vertical plate arrangement for cooling coils.
- Drain pan - Provide drainage facility for cooling coils to avoid standing water.
- Coil Testing
  - Pressure test coils to a minimum of 1.5 times design working pressure to ensure leak tight manufacture, and provide signed test certificates. Base coil design and sizing on performance test figures in line with BS 5141-1 for cooling coils and with BS 5141-2 for heating coils.
  - Coils in AHUs to be rated in accordance with BS EN 1216
- Packaging
  - Fit protection for fins prior to despatch.
  - Protect coils from dirt after manufacture by fitting blank flanges / caps to pipe connections.

2040# HEATER BATTERIES - ELECTRIC:

- Terminal Box
  - Construct terminal box of welded steel. Ensure box is treated to provide protection in accordance with BS EN 60529.
- Safety cut-out
  - Provide manual reset safety cut-out switch, wired in series or via contactor with heating elements.
  - Set point - 130°C
- Controls
  - Control panel to include a lockable door interlocked isolator.
  - Provide fan interlock to prevent heating running without fan running.
  - Provide run-on timer to allow airflow to cool heater before switching off fan.
  - Provide facility for 0-10Vdc control signal from remote source.
  - Provide volt free run and trip indication for BMS monitoring.
  - Provide manual reset thermal cut out switch.
- Air flow switch
  - On electric heating coils provide air flow detector switch wired in series with other safety devices.

2070 RUN-AROUND COILS:

- Casing
    - Casing finish to be manufacturer's standard unless indicated otherwise in the particular specification.
    - Enclose body of coil, headers and bends within casing.
    - Make provisions for expansion movement where pipe connections pass through casing and seal against leakage.
    - Provide plugs in headers to permit internal cleaning coils.
- Draining and venting
    - Provide plugged connections in headers to allow fitting of drain cocks / air vents.
    - Provide coil complete with venting and draining devices.
- Droplet eliminator
    - If there is a risk of condensation and the air velocity through the coil exceeds 2.5 m/s fit a droplet eliminator.
- Drain tray - Provide stainless steel drain tray for both coils.
- Coil Testing
    - Pressure test coils to a minimum of 1.5 times design working pressure to ensure leak tight manufacture, and provide signed test certificates. Base coil design and sizing on performance test figures in line with BS 5141-2 heating coils or test coils to establish the performance in accordance with BS EN 1216
    - Coils in AHU's to be rated in accordance with BS EN 1216.
- Packaging
    - Fit protection for fins prior to despatch. Protect coils from dirt after manufacture by fitting blank flanges / caps to pipe connections and enclosing complete units in dustproof containers.
- Accessories
    - Fit a pressure gauge complete with copper alloy gauge cock with lever handle in the pump discharge connection.

2090 PLATE HEAT EXCHANGER:

- Units to be performance tested in accordance with BS EN 308 using the relevant testing protocol of Eurovent and shall be complete with bypass (with pressure drop across the bypass, the same as the heat exchanger).

3000 ACCESSORIES

3010 DRIP TRAYS:

- Incorporate drip tray into base of casing to collect condensate. Fit at a small gradient towards drain socket provided in bottom of tray. Extend tray under external headers/return bends where these are not insulated/ vapour sealed. Extend tray, or provide additional tray, where eliminator plates are fitted.
- Provide removable drip trays.
- Where coils are over 1200mm high provide additional drip trays at 1200mm centre intervals maximum over height of coils, piped in copper or plastic to discharge into base tray.
- Paint internal surfaces with two coats of epoxy resin or alternative water proofing compound.

3020# DRAIN TRAPS:

- Provide drain trap at least twice working air pressure in depth. Provide an air break between trap outlet and drainage system.
- Arrangement
    - Ensure traps under suction have outlet lower than inlet by depth equivalent to at least one and a half times working pressure.
    - Ensure traps under positive pressure have inlet and outlet at same level.
- Pipe each trap to drain via a tun-dish or pipe each trap separately to discharge over a gully to prevent the potential of cross contamination between AHU's.
- Label each trap to state that it must be checked regularly / kept topped-up.
- Where freezing could occur insulate and trace-heat traps.
- Material - glass unless specified otherwise in the particular specification.

3030 ELIMINATOR PLATES:

- Install bank of eliminator plates downstream of coils to prevent carry over of condensate at design air face velocity. Fit plates to allow independent removal from coil casing. Ensure material of eliminators is compatible with casing.

3040 MOUNTING FRAME:

- On heating coils provide mounting frame for grouting into wall.

3050A AHU DUCT CONNECTIONS:

- To match air handling unit and specified method of assembly.

3050B EXTERNAL FLANGE DUCT CONNECTIONS:

- With external flanges drilled for bolting to counter flanges on adjacent plant or ductwork.

3050C INTERNAL FLANGE DUCT CONNECTIONS

- With internal flanges drilled for bolting to counter flanges on adjacent plant or ductwork.

3050D SPIGOT DUCT CONNECTIONS:

- With spigot duct connections.

4000 WORKMANSHIP

4010 POSITION / LOCATION:

- Install coils, heater batteries and heat recovery equipment in air distribution system as indicated. Locate in positions where air velocity is substantially equal over face of approach duct.
- Arrange steam coils for horizontal air flow.
- Ensure equipment, controls and instruments positioned adjacent to heating coils, heater batteries and heat recovery equipment are not adversely affected by thermal radiation.

4020A COOLING COIL CONNECTIONS:

- Provide a drain line incorporating deep seal trap.

4040 PROTECTION:

- Protect coils, heater batteries and heat recovery equipment from damage and ingress of dirt during the course of contract. Restore fins and other parts of coils, heater batteries and heat recovery equipment to original condition if any damage has occurred. Ensure all connected ductwork is thoroughly clean before removing protection and passing air through system.

4050 EQUIPMENT INSTALLATION:

- Install equipment in accordance with manufacturer's recommendations.
- Ensure maintenance requirements are incorporated.

Y45 - SILENCERS AND ACOUSTIC TREATMENT

1010 PERFORMANCE:

- Ensure that specified performance is met where protection is applied to infill to protect from moisture and grease.

1020 TESTING:

- Provide certified insertion loss data in accordance with BS EN ISO 7235.
- Provide generated sound power levels with insertion loss data.

1030 PROTECTION:

- Protect silencers where they are installed in positions exposed to external weather conditions.
- Block ends of silencers prior to delivery to site to prevent damage.

1040 DIRECTION OF FLOW:

- Clearly mark direction of air flow on silencers.

2000 PRODUCT/MATERIALS

2010# FIRE PROPERTIES:

- Use non-flammable adhesives. Ensure that all insulating materials and coverings are
  - non-combustible material covered with a material that complies with flame spread requirements of BS 476-7, Class 1.
  - Class O surface rating of Building Regulations.

2020A CIRCULAR SILENCERS - CASING TO DW144 WITH EXTERNAL FLANGES:

- Provide circular silencers compatible with ductwork installation. Provide infill that is inert, fire proof, inorganic, vermin proof, non-hygroscopic.
- Construct casing to DW/144 with external flanges drilled for bolting to counter flanges on adjacent plant or ductwork.

2020B CIRCULAR SILENCERS - CASING TO DW144 WITH INTERNAL FLANGES:

- Provide circular silencers compatible with ductwork installation. Provide infill that is inert, fire proof, inorganic, vermin proof, non-hygroscopic.
- Construct casing to DW/144 with internal flanges drilled and threaded for bolting to counter flanges on adjacent plant or ductwork.

2020C CIRCULAR SILENCERS - CASING TO DW144 WITH SPIGOT ENDS:

- Provide circular silencers compatible with ductwork installation. Provide infill that is inert, fire proof, inorganic, vermin proof, non-hygroscopic.
- Construct casing to DW/144 with plain spigot ends for connection to adjacent plant or ductwork.

2030A CIRCULAR SILENCERS - NON-METAL WITH EXTERNAL FLANGES:

- Provide circular silencers compatible with ductwork installation.
- Provide with external flanges drilled for bolting to counter flanges on adjacent plant or ductwork.

2030B CIRCULAR SILENCERS - NON-METAL WITH INTERNAL FLANGES:

- Provide circular silencers compatible with ductwork installation.
- Provide with internal flanges drilled and threaded for bolting to counter flanges on adjacent plant or ductwork.

2030C CIRCULAR SILENCERS - NON-METAL WITH SPIGOT ENDS:

- Provide circular silencers compatible with ductwork installation.
- Provide with plain spigot ends for connection to adjacent plant or ductwork.

2040A RECTANGULAR SILENCERS - CASING TO DW144 WITH CONNECTIONS TO MATCH AHU:

- Provide rectangular silencers compatible with ductwork installation. Provide infill that is inert, fire proof, inorganic, vermin proof, non-hygroscopic.
- Construct splitters with manufacturer's standard ends.
- Construct casing to DW/144 with duct connections to match the air handling unit and specified method of assembly.

2040B RECTANGULAR SILENCERS - CASING TO DW144 WITH EXTERNAL FLANGES:

- Provide rectangular silencers compatible with ductwork installation. Provide infill that is inert, fire proof, inorganic, vermin proof, non-hygroscopic.
- Construct splitters with manufacturer's standard ends.
- Construct casing to DW/144 with external flanges drilled for bolting to counter flanges on adjacent plant or ductwork.

2040C RECTANGULAR SILENCERS - CASING TO DW144 WITH INTERNAL FLANGES:

- Provide rectangular silencers compatible with ductwork installation.
- Provide infill that is inert, fire proof, inorganic, vermin proof, non-hygroscopic.
- Construct splitters with manufacturer's standard ends.
- Construct casing to DW/144 with internal flanges drilled and threaded for bolting to counter flanges on adjacent plant or ductwork.

2040D RECTANGULAR SILENCERS - CASING TO DW144 WITH LOW LOSS FAIRINGS AND CONNECTIONS TO MATCH AHU:

- Provide rectangular silencers compatible with ductwork installation. Provide infill that is inert, fire proof, inorganic, vermin proof, non-hygroscopic.
- Construct splitters with low loss fairings.
- Construct casing to DW/144 with duct connections to match the air handling unit and specified method of assembly.

2040E RECTANGULAR SILENCERS - CASING TO DW144 WITH LOW LOSS FAIRINGS AND EXTERNAL FLANGES:

- Provide rectangular silencers compatible with ductwork installation. Provide infill that is inert, fire proof, inorganic, vermin proof, non-hygroscopic.
- Construct splitters with low loss fairings.
- Construct casing to DW/144 with external flanges drilled for bolting to counter flanges on adjacent plant or ductwork.

2040F RECTANGULAR SILENCERS - CASING TO DW144 WITH LOW LOSS FAIRINGS AND INTERNAL FLANGES:

- Provide rectangular silencers compatible with ductwork installation. Provide infill that is inert, fire proof, inorganic, vermin proof, non-hygroscopic.
- Construct splitters with low loss fairings.
- Construct casing to DW/144 with internal flanges drilled and threaded for bolting to counter flanges on adjacent plant or ductwork.

2050A RECTANGULAR SILENCERS - NON-METAL WITH EXTERNAL FLANGES:

- Provide rectangular silencers compatible with ductwork installation.
- Construct splitters with manufacturer's standard ends.
- Provide external flanges drilled for bolting to counter flanges on adjacent plant or ductwork.

2050B RECTANGULAR SILENCERS - NON-METAL WITH INTERNAL FLANGES:

- Provide rectangular silencers compatible with ductwork installation.
- Construct splitters with manufacturer's standard ends.
- Provide internal flanges drilled and threaded for bolting to counter flanges on adjacent plant or ductwork.

2050C RECTANGULAR SILENCERS - NON-METAL WITH SPIGOT ENDS:

- Provide rectangular silencers compatible with ductwork installation.
- Construct splitters with manufacturer's standard ends.
- Provide spigot ends for connection to adjacent plant or ductwork.

2050D RECTANGULAR SILENCERS - NON-METAL WITH LOW LOSS FAIRINGS AND EXTERNAL FLANGES:

- Provide rectangular silencers compatible with ductwork installation.

- Construct splitters with low loss fairings.
- Provide external flanges drilled for bolting to counter flanges on adjacent plant or ductwork.

2050E RECTANGULAR SILENCERS- NON-METAL WITH LOW LOSS FAIRINGS AND INTERNAL FLANGES:

- Provide rectangular silencers compatible with ductwork installation.
- Construct splitters with low loss fairings.
- Provide internal flanges drilled and threaded for bolting to counter flanges on adjacent plant or ductwork.

2050F RECTANGULAR SILENCERS - NON-METAL WITH LOW LOSS FAIRINGS AND SPIGOT ENDS:

- Provide rectangular silencers compatible with ductwork installation.
- Construct splitters with low loss fairings.
- Provide spigot ends for connection to adjacent plant or ductwork.

2060A ACOUSTIC SPLITTERS TO MANUFACTURER'S STANDARD:

- Mount splitters vertically or horizontally and fix splitters as shown on drawings.
- Construct splitters to ensure that infill is retained and individual acoustic integrity is maintained.
- Construct splitters with manufacturer's standard ends.
- Provide additional stiffening on horizontally mounted splitters.
- Provide infill that is inert, fire proof, inorganic, vermin proof, non-hygroscopic.
- Material
    - Non-combustible mineral wool or glass fibre with minimum density 48 kg/m^3.
- Retain infill by perforated galvanized mild steel sheet.

2060B ACOUSTIC SPLITTERS WITH LOW LOSS FAIRINGS:

- Mount splitters vertically or horizontally and fix splitters as shown on drawings.
- Construct splitters to ensure that infill is retained and individual acoustic integrity is maintained.
- Construct splitters with low loss fairings.
- Provide additional stiffening on horizontally mounted splitters.
- Provide infill that is inert, fire proof, inorganic, vermin proof, non-hygroscopic.
- Material
    - Non-combustible mineral wool or glass fibre with minimum density 48 kg/m^3.
- Retain infill by perforated galvanized mild steel sheet.

2070A AIR TRANSFER/CROSS TALK ATTENUATORS - EXTERNAL FLANGES:

- Provide attenuators for air transfer and cross talk applications. Provide lining that is inert, fire proof, inorganic, vermin proof, non-hygroscopic.
- Construct casing with lock-formed longitudinal joints, mastic sealed.
- Provide external flanges drilled for bolting to counter flanges on adjacent ductwork.
- Fixing

- Interface with building components as indicated.

2070B AIR TRANSFER/CROSS TALK ATTENUATORS - INTERNAL FLANGES:

- Provide attenuators for air transfer and cross talk applications. Provide lining that is inert, fire proof, inorganic, vermin proof, non-hygroscopic.
- Construct casing with lock-formed longitudinal joints, mastic sealed.
- Provide internal flanges drilled and threaded for bolting to counter flanges on adjacent ductwork.
- Fixing
  - Interface with building components as indicated.

2070C AIR TRANSFER/CROSS TALK ATTENUATORS - SPIGOT ENDS:

- Provide attenuators for air transfer and cross talk applications. Provide lining that is inert, fire proof, inorganic, vermin proof, non-hygroscopic.
- Construct casing with lock-formed longitudinal joints, mastic sealed.
- Provide plain spigot ends for connection to adjacent ductwork.
- Fixing
  - Interface with building components as indicated.

2110 ACOUSTIC FLEXIBLE DUCT CONNECTORS:

- Provide acoustic flexible duct connectors in accordance with DW/144.

2120A ACOUSTIC LOUVRES:

- Performance
  - Provide certified acoustic performance data measured in accordance with BS EN ISO 10140.
  - Ensure louvre withstands specified wind loads and prevent ingress of rain.
- Construction
  - Construct louvre frame and aerodynamically profiled louvre blades from galvanized mild steel or aluminium as appropriate. Provide integral drainage channels.
- Screen
  - Fit a bird-screen using mesh no coarser than 12mm, across inside face of louvres.
- Quality assurance
  - Ensure manufacturers are a firm of Assessed Capability to BS EN ISO 9001 and produce louvre to relevant Quality Assessment schedule.

2120B ACOUSTIC LOUVRES WITH INFILL:

- Performance
  - Provide certified acoustic performance data measured in accordance with BS EN ISO 10140.

- Ensure louvre withstands specified wind loads and prevent ingress of rain.

- Construction
  - Construct louvre frame and aerodynamically profiled louvre blades from galvanized mild steel or aluminium as appropriate. Provide integral drainage channels.
  - Provide acoustic infill which is inert, fire proof, inorganic, vermin proof and non-hydroscopic.
  - Retain infill on louvre blades by perforated sheet of galvanized mild steel or aluminium as appropriate.
  - Acoustic infill to be wrapped with woven glass scrim cloth or 'Melinex' to prevent migration of particles into the airflow / protect the infill. Full account of the reduction in performance of the acoustic louvre brought about by the addition of the infill protection shall be made when selecting silencers to meet the required performances.

- Screen
  - Fit a bird-screen using mesh no coarser than 12mm, across inside face of louvres.

- Quality assurance
  - Ensure manufacturers are a firm of Assessed Capability to BS EN ISO 9001 and produce louvre to relevant Quality Assessment schedule.

3000 WORKMANSHIP

3030 ACCESS TO ACOUSTIC ENCLOSURES:

- Provide door type openings in enclosures as required for access to items enclosed. Provide openings for inlet and discharge ductwork and for connections as indicated. Provide angle flange connections for mating to ductwork and equipment.

3040 SUPPORTS:

- Supply steel section supporting frames or brackets where silencers are fixed to the walls of air chambers.

3060 SOUND PRESSURE LEVEL READINGS:

- Measure sound pressure levels at the positions indicated using equipment in accordance with BS EN 61672-1 and BS EN 61672-2.

Y46 - GRILLES, DIFFUSERS AND LOUVRES

1010 PERFORMANCE:

- Maximum mean air velocity in the occupied zone in summer and winter shall not exceed the criteria for a category B thermal environment as defined in BS EN ISO 7730 (PPD<10%) table A.5. unless specified otherwise elsewhere in this specification.
- Blades - Supply grilles and diffusers with blade profile to ensure correct aerodynamic performance and minimal noise generation.
- Louvres - Ensure air velocities through face area of louvres minimises 'carry-over' of rain, snow or other precipitation into ducts, shafts or plant rooms and ensure louvres are tested in accordance with BS EN 13030 and are subject of on-going factory production control auditing. Performance classes to BS EN 13030 are given elsewhere in this specification.

1020 SIZE:

- Sizes indicated are 'Nominal'.
- Provide size dimensions of linear diffusers and grilles before manufacture.

1030 NOISE LEVELS:

- Ensure sound power levels indicated are not exceeded. Ensure accessories for grilles and diffusers have low noise generation characteristics, and cause minimum disturbance to airflow.

1033 PROTECTIVE WRAPPING:

- Apply protective wrapping to exposed architectural finishes prior to despatch to site.

1040 ELECTRICAL BONDING TERMINAL:

- Ensure an electrical bonding terminal suitable for connection of 6mm^2 maximum conductor is provided on metal grilles, diffusers and louvres where indicated.

2000 PRODUCTS/MATERIALS

2010# GRILLES - FIXED BLADE TYPE:

- Secure blades within flanged mounting frame or core collar. Provide support mullions to ensure blade stability.

2020# GRILLES - ADJUSTABLE BLADE TYPE:

- Pivot blades within flanged mounting frame and retain blades in set position by tensioners external to the air stream.
    - Blade Rows
        - One row of parallel blades.

- Two rows of parallel blades at right angles to each other.

2050# GRILLES - LINEAR TYPE:

- Supply linear type grilles with one row of parallel blades. Secure blades within mounting frame or opening. Permanently set at angle indicated.

2060# GRILLES - LINEAR FLOOR TYPE:

- Supply linear type floor grilles with one row of parallel blades. Permanently set at angle indicated. Incorporate bar reinforcement.

2070C TRANSFER GRILLES - FIRE RESISTANT NON-VISION TYPE

- Supply grilles comprising Zintec steel frame with an intumescent core and two steel grilles, colour as indicated or scheduled.
- Comply with the requirements of BS 9999.
- Fire resistance tests for wall, ceiling or floor mounting types in accordance with BS EN 1364-5 or BS 476-22.
- Fire resistance tests for door mounting types in accordance with BS 476-22.
- Fix as indicated in accordance with the manufacturer's recommendations.

2070D TRANSFER GRILLES - FIRE RESISTANT NON-VISION TYPE WITH SMOKE CONTROL FACILITY:

- Supply grille assembly comprising Zintec steel frame with an intumescent core with damper and actuator assembly to automatically close in the event of an alarm, power failure or damage to wiring. Units to be complete with steel cover grilles, colour as indicated or scheduled.
- Comply with the requirements of BS 9999.
- Fire resistance tests for door mounting types in accordance with BS 476-20 and BS 476-22.
- Smoke leakage tests for smoke shutter type through door sets to be in accordance with BS 476-31.1.
- Fix as indicated in accordance with the manufacturer's recommendations.

2090A DIFFUSERS - LINEAR TYPE:

- Supply single unit or continuous length linear diffusers manufactured with one or more rigid and smooth line slot units with parallel bars and partitions.
- Fit closing caps at ends of single or multiple continuous length units.
- Provide continuous lengths complete with locating pins or strips with keys to ensure correct alignment of abutted ends.

2100 DIFFUSERS - PERFORATED FACE TYPE:

- Supply perforated face diffusers with rigid and smooth inlet spigot expanded to butt and seal against easily removable framed perforated front panel. Incorporate back deflectors above front panel, set to give required performance.
- Supply type and profile of framed perforated front panel to mount flush with surrounding false ceiling panels.

2130A STRAIGHT LINE, FIXED LOUVRE DIFFUSER WITH FIXED CORE:

- Supply diffusers manufactured from louvre type parallel blades permanently set and securely fixed within frame.
- Pre-set each blade to give directional control of air stream.

2130B STRAIGHT LINE, FIXED LOUVRE DIFFUSER WITH REMOVABLE CORE:

- Supply diffusers manufactured from louvre type parallel blades permanently set and securely fixed within frame.
- Supply core frames which are easily removable from flanged mounting frame.
- Pre-set each blade to give directional control of air stream.

2150 DIFFUSERS - LINEAR LIGHTING/AIR MODULAR TYPE:

- Supply diffusers complete with connecting unit for installation behind module flanges, ensuring neat and unobtrusive appearance.
- Fit plenum box with integral independent air volume regulating vanes to direct an equal air velocity along complete length of connecting air diffuser slot. Ensure easy access from below to regulating vanes. Retain vanes in set position by tensioners external to air stream.
- Fit spigot, suitable for flexible ducting joint connection to plenum box.
- Ensure that supports are independent, and do not depend upon module casing or flanges.

2160 LAMINAR FLOW PANELS:

- Supply laminar flow panels each with a large perforated face plate complete with rear plenum box or spigot entry.

2170 FILTERING ROOF, UNIDIRECTIONAL LAMINAR AIR SUPPLY

- equipped with pressure taps and terminal filters with minimum H14 efficiency (tested according to EN 1822) and perforated grids to ensure uniformity
- Very high efficiency filtration: H14 or U15
- Conforms to EN ISO 14644-1
- equipped with air recirculation boxes
- Acoustic version for attenuation of sound levels.

2180 DIFFUSERS - EXTRACT/EXHAUST VALVE TYPE:

- Supply diffusers incorporating intake ring and adjustable valve disc assembly. Provide bayonet type fixing for purpose made mounting ring with plastic foam sealing gasket. Provide setting template.
- Adjust valve to required setting and lock valve in required position.

2210# MATERIALS:

- Aluminium sheet/extruded aluminium
    - To BS EN 485, BS EN 515 and BS EN 573, or BS EN 755.

- Finish
    - Baked enamel, color selected by Engineer

2220A GRILLE AND DIFFUSER CONSTRUCTION:

- Ensure grilles and diffusers are robust and mounting frame flanges on square and rectangular terminals have mitred corners. Fit a rubber or plastic foam sealing strip or gasket to rear face of flange.
- Diffusers - Ensure face of diffuser outer cone or frame is completely smooth.

3000 ACCESSORIES

3010A OPPOSED BLADE VOLUME CONTROL DAMPERS - LOCAL CONTROL:

- Balance and tension operating mechanisms to give positive setting for blade positions from fully open to fully closed.
- Local blade operation
    - Supply device for operating damper blades through face or side of grille/diffuser as indicated.

3030A ANNULAR RING VOLUME CONTROL DAMPERS:

- Provide manual operation by loose key.

3040A BUTTERFLY VOLUME CONTROL DAMPERS:

- Operate via a simple hooked wire key connecting with a lug on the underside of each plate; or by a loose key locating into a control mechanism.

3060A FIXED AIR FLOW DEFLECTORS:

- Direct air stream evenly from main ducting into branches or spigots serving air grilles and diffusers by using a number of equally spaced curved blades linked together.

3060B ADJUSTABLE AIR FLOW DEFLECTORS:

- Direct air stream evenly from main ducting into branches or spigots serving air grilles and diffusers by using a number of equally spaced curved blades linked together.

3070 BLANKING PLATES:

- Supply blanking plates to restrict projection of air flow from a particular section of grille or diffuser. Ensure that indicated dimensions or angles in degrees are maintained.

3090 PERFORATED SCREENS:

- Fit perforated screens behind grille volume control devices to equalize air flow and pressure. Contain perforated sheet within rigid surrounding frame, incorporating fixing brackets or lugs.

4000 WORKMANSHIP

4010 GRILLE/DIFFUSER LOCATION:

- Fit at terminal air supply, extract and transfer points indicated, in accordance with the HEVAC Air Diffusion Guide.

4040 CONNECTION TO DUCTWORK:

- When connecting directly to duct spigot, secure grille mounting frame or flange with screws, or bolts and nuts, to returned flange, with filled in corners, at end of duct spigot.

4050A INSTALLATION IN BUILDERS WORK:

- Ensure outer edge of grille mounting frame or flange extends on all sides beyond the joint between any builders work frame and surrounding building construction.
- Ensure grilles are sealed to building fabric - including ceilings, to prevent air leakage from pressurised rooms to voids above.
- Fix louvres to building fabric using method indicated on drawings.

Y50 - THERMAL INSULATION

1010 TEMPERATURE RANGE:

- Refer to insulation manufacturer's recommendations to determine suitability of different insulation materials at different temperature ranges.

1020 STANDARDS:

- Comply in general with
  - BS 5422
  - BS 5970
  - BS EN ISO 12241
- For product clauses comply with
  - BS EN 14303
  - BS EN 14304
  - BS EN 14314
- Use the description of terms as BS 3533.
- All insulation products must have a Declaration of Performance (DoP) certificate and be CE marked in accordance with the Construction Products Regulations (CPR).
- Comply with BS EN 16783 and BS EN 15804 in preparing environmental product declarations (EPD's)

1030 MATERIALS:

- Employ materials that comply with BS 476-6 and BS 476-7.
- Materials shall have obtained Class 'O' fire rating in accordance with Approved Document B of the Building Regulations or be non-combustible in accordance with BS 476-4.
- Materials classified according to BS EN 13501-1 shall not show propensity for continuous smouldering combustion when tested in accordance with BS EN 16733.
- Ensure metals and materials that cause galvanic corrosion are not installed in contact.
- Do not use galvanized or zinc coated steel jacketing and accessories on austenitic stainless steel and austenitic nickel steel/alloy equipment and piping.
- Insulants can be selected from BRE Green Guide to Specification.
- All insulation material shall
  - Be non-hydroscopic and in all respects be suitable for continuous use throughout the range of operating temperatures and within the environment indicated.
  - Be wholly compatible with the material it is insulating at the design working temperature and environmental conditions.
  - Be free from chemicals which may contribute to corrosion or degradation of the insulated surface or finish.
  - Have global warming potential (GWP) of less than 5.
  - Have an ozone depletion potential (ODP) of 0.

1032 PRE-INSULATED EQUIPMENT:

- Where fire and surface spread of flame certificates relate to factory made products, ensure that certificates are still valid where products are incorporated in pre-insulated equipment.

1034 PROTECTION APPLIED IN SITU:

- Where fire and surface spread of flame certificates relate to factory made products, ensure that the certificate remains valid when the finish is site applied.

1035A EUROPEAN CLASSIFICATION FOR REACTION TO FIRE PERFORMANCE:

- Supply insulating materials classified in accordance with BS EN 13501-1. Classes acceptable are $A1/A1_L$, $A2/A2_L$ or B/B_L having smoke emission classification of s1 and production of flaming droplets/particles classification of d0.
- Test methods
  - BS EN ISO 1182, BS EN ISO 1716, BS EN 11925-2, BS EN 13823 as appropriate.

1050A SPREAD OF FLAME:

- When completed, ensure surface-finish complies with BS 476-7 Class 1 spread of flame.

1055 SMOKE EMISSION CHARACTERISTICS:

- Ensure only products classified by BS EN 13501-1 as s1 (materials that give off little or no smoke) are used.

1080 ELECTRICAL BONDING TERMINAL:

- Ensure an electrical bonding terminal suitable for connection of $6mm^2$ maximum conductor is provided where indicated.

1090 INSPECTION AND TESTING:

- Arrange performance test of thermal conductivity on materials selected, carried out at manufacturer's works or at an approved laboratory and in accordance with appropriate British Standard.
- Provide assistance to allow for inspection of all sizes of insulation on all services after installation to determine thickness and compliance with specification. Make good any sections that are cut during inspection for thickness and compliance with specification.

2000 PRODUCTS/MATERIALS

2010 THERMAL CONDUCTIVITY:

- All thermal conductivity figures given in insulation product clauses are typical values at the mean temperature stated, as declared in manufacturer's Declaration of Performance (DoP) certificates in accordance with the CPR.

2015A THERMAL PERFORMANCE LIFE EXPECTANCY FOR PLANT DESIGN LIFE:

- Ensure the insulation will maintain it's thermal performance for a minimum of the plant design life.

2015B THERMAL PERFORMANCE LIFE EXPECTANCY DETAILS:

- Provide manufacturer's details which define the life expectancy of the insulation material. Where appropriate this shall include both 'as manufactured' and 'aged' thermal conductivity values in accordance with BS EN 14314.

2020 RESTRICTIONS ON USE OF MATERIALS:

- Protect insulated stainless steel surfaces from the risk of stress corrosion in accordance with the recommendations in BS 5970.
- For all mineral wool insulation products, test evidence must be available showing that the fibres from which the products are made are not classified as a possible human carcinogen, as detailed by European Directive 97/69/EC and the Approved Supply List of CHIP98, and that the fibres should be bio-soluble.

2030A FOIL FACED ROCK MINERAL WOOL PIPE INSULATION:

- Standard - BS EN 14303.
- Nominal density - 120 kg/m^3.
- Thickness - 20mm to 100mm.
- Thermal conductivity - Typical value 0.033 - 0.034 W/mK at a mean temperature of 10°C.
- Finish - Reinforced aluminium foil with at least 25mm overlap.

2030B CANVAS ROCK MINERAL WOOL PIPE INSULATION:

- Standard - BS EN 14303.
- Nominal density - 120 kg/m^3.
- Thickness - 20mm to 100mm.
- Thermal conductivity - Typical value of 0.033 - 0.034 W/mK at a mean temperature of 10°C.
- Finish - Canvas covered with at least 25mm overlaps.

2030C FOIL FACED GLASS MINERAL WOOL PIPE INSULATION:

- Standard - BS EN 14303.
- Nominal density - 80 kg/m^3.
- Thickness - 20mm to 100mm.
- Thermal conductivity - Typical value of 0.033 W/mK at a mean temperature of 10°C.

2030D CANVAS GLASS MINERAL WOOL PIPE INSULATION:

- Standard - BS EN 14303.
- Nominal density - 80 kg/m^3 to 120 kg/m^3.
- Thickness - 20mm to 100mm.
- Thermal conductivity - Typical value of 0.033 W/mK at a mean temperature of 10°C.

- Finish - Canvas covered with at least 25mm overlaps.

2040A FOIL FACED ROCK MINERAL WOOL SEMI RIGID DUCT INSULATION:

- Standard - BS EN 14303.
- Nominal density - 45 kg/m^3.
- Thickness - 25mm to 100mm.
- Thermal conductivity - Typical value not exceeding 0.034 W/mK at a mean temperature of 10°C.
- Finish - Reinforced aluminium foil.

2040B FOIL FACED GLASS MINERAL WOOL SEMI RIGID DUCT INSULATION:

- Standard - BS EN 14303
- Nominal density - 45 kg/m^3.
- Thickness - 25mm to 100mm.
- Thermal conductivity - Typical value of 0.333 W/mK at a mean temperature of 10°C.
- Finish - Reinforced aluminium foil.

2050A FOIL FACED ROCK MINERAL WOOL FLEXIBLE DUCT INSULATION:

- Standard - BS EN 14303
- Nominal density - 28 kg/m^3 to 45 kg/m^3.
- Thickness - 25mm to 60mm.
- Thermal conductivity - Typical value of 0.034 W/mK at a mean temperature of 10°C.
- Finish - Reinforced aluminium foil.

2050B FOIL FACED GLASS WOOL FLEXIBLE DUCT INSULATION:

- Standard - BS EN 14303
- Nominal density - 25 kg/m^3 to 45 kg/m^3.
- Thickness - 25mm to 60mm.
- Thermal conductivity - Typical value of 0.033 W/mK at a mean temperature of 10°C.
- Finish - Reinforced aluminium foil.

2060A FOIL FACED ROCK MINERAL WOOL LAMELLA DUCT INSULATION:

- Standard - BS EN 14303
- Nominal density - 24-45 kg/m^3.
- Thickness - 25mm to 80mm.
- Thermal conductivity - Typical value of 0.04 W/mK at a mean temperature of 10°C.
- Finish - Reinforced aluminium foil.

2060B KRAFT PAPER FACED ROCK MINERAL WOOL LAMELLA DUCT INSULATION:

- Standard - BS EN 14303
- Nominal density - 24-45 kg/m^3.
- Thickness - 25mm to 80mm.

- Thermal conductivity - Typical value of 0.04 W/mK at a mean temperature of 10°C.
- Finish - Plain Kraft paper.

2060C FOIL FACED GLASS MINERAL WOOL LAMELLA DUCT INSULATION:

- Standard - BS EN 14303.
- Nominal density - 24-45 kg/m^3.
- Thickness - 25mm to 80mm.
- Thermal conductivity - Typical value of 0.04 W/mK at a mean temperature of 10°C.
- Finish - Reinforced aluminium foil.

2060D KRAFT PAPER FACED GLASS MINERAL WOOL LAMELLA DUCT INSULATION:

- Standard - BS EN 14303.
- Nominal density - 24-45 kg/m^3.
- Thickness - 25mm to 80mm.
- Thermal conductivity - Typical value of 0.04 W/mK at a mean temperature of 10°C.
- Finish - Plain Kraft paper.

2065 CRIMPED MAT DUCT INSULATION:

- Standard - BS EN 14303
- Nominal density - 25 to 45 kg/m^3.
- Compression resistance - Maximum of 13% compression at a static load of 2 kPA.
- Thickness - 25mm to 80mm.
- Thermal conductivity - Typical value of 0.034 W/mK at a mean temperature of 10°C.
- Finish - Reinforced aluminium foil.

2070A GALVANIZED METAL MESH ON MINERAL WOOL MATTRESSES - ONE FACE:

- Standard - BS EN 14303
- Application - High temperature ducts, tanks, vessels and other process equipment.
- Nominal density - 66 - 128 kg/m^3.
- Thickness - 25mm to 100mm.
- Thermal conductivity - Typical value of 0.041 W/mK at a mean temperature of 50°C.
- Mesh - Galvanized. Faced, one side.

2070B GALVANIZED METAL MESH ON MINERAL WOOL MATTRESSES - BOTH FACES:

- Standard - BS EN 14303.
- Application - High temperature ducts, tanks, vessels and other process equipment.
- Nominal density - 66 - 128 kg/m^3.
- Thickness - 25mm to 100mm.
- Thermal conductivity - Typical value of 0.041 W/mK at a mean temperature of 50°C.
- Mesh - Galvanized. Faced, both sides.

2070C STAINLESS STEEL MESH ON MINERAL WOOL MATTRESSES - ONE FACE:

- Standard - BS EN 14303
- Application - High temperature ducts, tanks, vessels and other process equipment.
- Nominal density - 66 - 128 kg/m^3.
- Thickness - 25mm to 100mm.
- Thermal conductivity - Typical value of 0.041 W/mK at a mean temperature of 50°C.
- Mesh - Stainless steel. Faced, one side.

2070D STAINLESS STEEL MESH ON MINERAL WOOL MATTRESSES - BOTH FACES:

- Standard - BS EN 14303
- Application - High temperature ducts, tanks, vessels and other process equipment.
- Nominal density - 66 - 128 kg/m^3.
- Thickness - 25mm to 100mm.
- Thermal conductivity - Typical value of 0.041 W/mK at a mean temperature of 50°C.
- Mesh - Stainless steel. Faced, both sides.

2080A FLAT DUCTWORK FIRE PROTECTION INSULATION - MITRED JOINTS:

- Material - Mineral wool, slab for flat ducts, with 45° mitred joints.
- Nominal density - 165 kg/m^3.
- Thermal conductivity - Typical value of 0.035 W/mK at a mean temperature of 10°C.
- Facing - Reinforced aluminium foil.

2080B FLAT DUCTWORK FIRE PROTECTION INSULATION - BUTTED JOINTS:

- Material - Mineral wool, slab for flat ducts, with 90° butted joints.
- Nominal density - 165 kg/m^3.
- Thermal conductivity - Typical value of 0.035 W/mK at a mean temperature of 10°C.
- Facing - Reinforced aluminium foil.

2080C CIRCULAR DUCTWORK FIRE PROTECTION INSULATION - SECTION:

- Material - Mineral wool
    - Section for circular duct, 17 to 610 mm diameter.
- Nominal density - 165 kg/m^3.
- Thermal conductivity - Typical value of 0.035 W/mK at a mean temperature of 10°C.
- Facing - Reinforced aluminium foil.

2080D CIRCULAR DUCTWORK FIRE PROTECTION INSULATION - PSM:

- Material - Mineral wool
    - PSM for circular duct greater than 406mm diameter.
- Nominal density - 165 kg/m^3.
- Thermal conductivity - Typical value of 0.035 W/mK at a mean temperature of 10°C.
- Facing - Reinforced aluminium foil.

2080E CIRCULAR DUCTWORK FIRE PROTECTION INSULATION - FLEXIBLE MAT:

- Material - Mineral wool wire faced flexible mattress.
- Nominal density - 66 kg/m^3.
- Thermal conductivity - Typical value of 0.035 W/mK at a mean temperature of 10°C.
- Facing - Reinforced aluminium foil.

2110A FOIL FACED CLOSED CELL RIGID PHENOLIC FOAM (PF) PREFORMED SECTIONS:

- Standard - BS EN 14314
- Nominal density - 35 - 40 kg/m^3..
- Temperature range - -180 to +120°C..
- Thickness - Minimum 15mm.
- Thermal conductivity - Typical value of 0.025 W/mK at a mean temperature of 10°C when fully aged in accordance with BS EN 14314.
- Finish - Reinforced aluminium foil.
- Phenolic foam sections to be completely treated, at the insulation manufacturer's works, with a suitable dust suppressant, acid neutralising and passivating bore coating. This can be either an impregnated permeable liner or a sprayed coating.

2120A FOIL FACED CLOSED CELL RIGID LAMINATED PHENOLIC FOAM (PF), DUCT INSULATION SLAB:

- Standard - BS EN 14314.
- Nominal density - 40 kg/m^3.
- Thickness - minimum 20mm.
- Thermal conductivity - Typical value of 0.022 W/mK at a mean temperature of 10°C when fully aged in accordance with BS EN 14314.
- Finish - Reinforced aluminium foil.

2120B CLOSED CELL RIGID LAMINATED PHENOLIC FOAM (PF), DUCT INSULATION SLAB:

- Standard - BS EN 14314
- Nominal density - 40 kg/m^3.
- Thickness - minimum 20mm.
- Thermal conductivity - Typical value of 0.022 W/mK at a mean temperature of 10°C when fully aged in accordance with BS EN 14314.

2130A HIGH DENSITY RIGID PHENOLIC PIPE AND DUCT INSULATION FOR DUCT AND PIPE SUPPORTS:

- Standard - BS EN 14314
- Nominal density - 40 kg/m^3.
- Temperature range - -180 to +12°C.
- Thermal conductivity - Typical value of 0.045 W/mK at a mean temperature of 50°C when fully aged in accordance with BS EN 14314.

- CFC and HCFC free.

2140A CLOSED CELL NITRILE AND EPDM RUBBER ELASTOMERIC SHEET AND PREFORMED FLEXIBLE SECTIONS:

- Standard - BS EN 14304
- Nitrile rubber
    - Nominal density - 45 - 100 kg/m^3.
    - Temperature range - -50 to +110°C.
- Thickness
    - Sections - 6mm to 32mm for pipe sizes 6mm to 114mm.
    - Sheets - 6mm to 50mm.
    - Thermal conductivity - Typical value of 0.036 W/mK at a mean temperature of 20°C.
- EPDM
    - Nominal density - 45 - 100 kg/m^3.
    - Temperature range - -50 to +150°C
- Thickness
    - Sections - 10mm to 25mm for pipe sizes 10mm to 89mm.
    - Sheets - 10mm to 32mm.
    - Thermal conductivity - Typical value 0.045 W/mK at a mean temperature of 40°C.

2170 VAPOUR BARRIER PERMEANCE:

- Comply with requirements of BS 5422 and BS 5970.
- Maximum permitted water vapour permeance in relation to plant temperature at an ambient temperature of +20°C (dry bulb) to be in accordance with BS 5422, Table 1.

2180A BITUMEN VAPOUR BARRIER COATINGS:

- Cut-back bitumens with cotton canvas or open mesh glass cloth to reinforce coatings.

2180B VINYL VAPOUR BARRIER COATINGS:

- Vinyl emulsions with cotton canvas or open mesh glass cloth to reinforce coatings.

2180C SOLVENT POLYMER VAPOUR BARRIER COATINGS:

- Solvent-based polymers with cotton canvas or open mesh glass cloth to reinforce coatings.

2180D BITUMEN EMULSION VAPOUR BARRIER COATINGS:

- Bitumen emulsions (with or without elastomer latex) with cotton canvas or open mesh glass cloth to reinforce coatings.

2190 ADHESIVES:

- Comply with the recommendations of clause 10.1 of BS 5970, for insulation bonding adhesives, lagging adhesives; and facing and film attachment adhesives.

2200A SELF ADHESIVE WEATHER RESISTANT ZERO PERM MULTI-LAYER LAMINATE:

- Apply multi-layer laminate directly over ducts and pipework, ensuring 75mm overlap for a complete vapour barrier.
- Test in accordance with BS 476-6 and BS 476-7.
- Finish - Class O
- Laminate to be puncture and tear resistant and have supporting test data in accordance with ASTM D-1000 and ASTM D-624.
- Normal use -5ply laminate.
- Heavy duty use (e.g. Pipework /ductwork which could be walked on regularly or low level pipework in plant areas) -13ply laminate.
- Installation to be in accordance with the manufacturer's recommendations and may be either factory pre-applied or applied in-situ.

2200B ROOFING FELT PROTECTION:

- Secure in position with galvanized wire netting, of 1mm x 25mm mesh. Finish with two coats of black bituminous paint.

2200C FLAT ALUMINIUM-ZINC COATED STEEL PROTECTION:

- Mild steel sheet continuously hot dipped with 185gm aluminium-zinc coating to BS EN 10346, applied directly to insulating material.
- 0.4mm thick flat sheet.

2200D RIBBED ALUMINIUM-ZINC COATED STEEL PROTECTION:

- Mild steel sheet continuously hot dipped with 185gm aluminium-zinc coating to BS EN 10346, applied directly to insulating material.
- 0.4mm thick ribbed sheet.

2200E ALUMINIUM SHEETING PROTECTION:

- Apply flat (embossed) or profiled aluminium cladding directly to insulating material. 0.56mm thick on pipework; 0.71mm thick on ductwork.

2200G CANVAS PROTECTION:

- 130g covering for ductwork with two coats of water based co-polymer solution.
- Canvas sections for pipework with two coats of water based co-polymer solution.

2200H CANVAS PROTECTION WITH ALUMINIUM BANDS:

- 130g covering for ductwork with two coats of water based co-polymer solution, with aluminium bands.
- Canvas sections for pipework with two coats of water based co-polymer solution, with aluminium bands.

2210# REINFORCEMENT:

- Aluminium bands at 300mm centres.
- Aluminium bands at 450mm centres.
- 50mm x 19g galvanised wire netting to BS EN 10223.
- 50mm x 22g galvanised wire netting to BS EN 10223.

2230A ALUMINIUM PROTECTION FOR HEAT EXCHANGERS AND OTHER VESSELS:

- Finish with 0.9mm thick aluminium ribbed or embossed sheeting, with lapped, riveted and sealed joints, laps to shed water. Seal all joints at manholes and stools. Fit cut-outs with purpose made over-plates or collars.

2230B ALUMINIUM PROTECTION FOR HEAT EXCHANGERS AND OTHER VESSELS - WITH CHEST AND ACCESS COVERS:

- Finish with 0.9mm thick aluminium ribbed or embossed sheeting, with lapped, riveted and sealed joints, laps to shed water. Seal all joints at manholes and stools. Fit cut outs with purpose made over-plates or collars.
- Enclose chests and access covers in removable covers lined with high density flexible material. Remove manufacturer's name plate and refix on cladding.

2230E MULTI-LAYER LAMINATE PROTECTION FOR HEAT EXCHANGERS AND OTHER VESSELS - WITH CHEST AND ACCESS COVERS:

- Finish with self-adhesive weather resistant zero perm multi-layer laminate to encapsulate insulation, using the taped system as a quick and easy access point.

2240A MINERAL FIBRE INSULATION FOR BOILER FLUES WITH ALUMINIUM CASING:

- Use bonded mineral fibre preformed sections secured with aluminium bands direct to flue. Use multi-layers and stagger joints for thicknesses in excess of 65mm. Finish with 0.9mm thick aluminium ribbed or embossed sheeting.

2280 PUMPS AND OTHER IRREGULAR SHAPES:

- Where access is required to pumps and other irregular shapes submit proposals for materials and methods of applying a demountable finish, for approval.
- Comply with requirements of BS 5970.

2287 CALCULATION OF INSULATION THICKNESS - ECA ENHANCED:

- The insulation manufacturer selected for a particular project should calculate the minimum required thicknesses of pipework insulation based on the actual conductivity of the product at the relevant temperature and the criteria on the ECA web site for an eligible installation using the methodology set out in BS EN ISO 12241 and the assumptions set out in Table C1 of BS 5422.

2289 INSULATION THICKNESS TABLES:

- Unless stated otherwise the thicknesses given in the tables in this specification are the nearest commercially available material thickness to meet the minimum calculated thickness to BS EN ISO 12241 and the product declared performance data for CE marking. Thicknesses have been calculated by manufacturers for each product and use thermal conductivity values calculated from the mean insulation temperature based on the fluid and air temperatures listed in the relevant tables.
- Should alternative products be offered that may have different performance data the Contractor shall ensure the manufacturer undertakes calculations and submits appropriate thickness table.
- Unless specified otherwise elsewhere, the thicknesses for pipe of greater diameter, flat surfaces or irregular shaped plant items shall not be less than that for the largest pipe size given in the thickness tables.

2290 NON-DOMESTIC HOT WATER SERVICE INSTALLATIONS - BUILDING REGULATIONS ROCK MINERAL WOOL:

- Insulation thickness to achieve the maximum permissible heat loss stated in the Building Regulations Part L Non Domestic Building Services Compliance Guide, Northern Ireland Technical Booklet F2 and Section 6 of the Scottish Non Domestic Technical Handbook.

Outside diameter of steel pipe (mm)	Thickness of rock mineral wool (mm)	
Surface emissivity	0.05	0.9
17	25	30
21	25	30
27	30	35
34	30	35
42	30	35
48	35	40
60	40	40
76	35	45
89	35	45
114	40	45
140	40	45
168	40	50
219	40	50
273 and above	45	50

- Basis: Horizontal pipe at 60°C in still air at 15°C, thermal conductivity values calculated from the mean insulation temperature based on the fluid and air temperatures.
    - Use this table for insulation thickness of copper pipework of the nearest equivalent outside diameter.

- Use this table for insulation thickness of plastic pipework of the nearest equivalent outside diameter.

2295 NON-DOMESTIC HOT WATER SERVICE INSTALLATIONS, BUILDING REGULATIONS - GLASS MINERAL WOOL:

- Insulation thickness to achieve the maximum permissible heat loss stated in the Building Regulations Part L Non Domestic Building Services Compliance Guide, Northern Ireland Technical Booklet F2 and section 6 of the Scottish Non Domestic Technical Handbook.

Outside diameter of steel pipe (mm)	Thickness of glass mineral wool (mm)	
Surface emissivity	0.05	0.9
17	25	30
21	25	30
27	30	40
34	30	40
42	30	40
48	40	40
60	40	40
76	40	40
89	40	40
114	40	50
140	40	50
168	40	50
219	40	50
273 and above	40	50

- Basis: Horizontal pipe at 60°C in still air at 15°C, Thermal conductivity calculated from the mean insulation temperature based on the fluid and air temperatures.
    - Use this table for insulation thickness of copper pipework of the nearest equivalent outside diameter.
    - Use this table for insulation thickness of plastic pipework of the nearest equivalent outside diameter.

2307 NON-DOMESTIC HOT WATER SUPPLY SERVICES, ECA ENHANCED:

- The insulation manufacturer selected for a particular project should calculate the minimum required thicknesses of pipework insulation based on the actual conductivity of the product at the relevant temperature and the criteria on the ECA web site for an eligible installation using the methodology set out in BS EN ISO 12241 and the assumptions set out in Table C1 of BS 5422: 2009. The table below defines the maximum permissible heat losses to be used in the calculations.

Non-Domestic Hot Water Supply Maximum Permitted Heat Loss (W/m)

Temperature	60°C
Outside Pipe Diameter (mm)	
17.2	6.04
21.3	6.45
26.9	7.00
33.7	7.71
42.4	8.46
48.3	9.01
60.3	9.94
76.1	11.25
88.9	12.17
114.3	14.29
139.7	16.09
168.3	18.24
219.1	22.06
273 & above	25.95

2310 NON-DOMESTIC HEATING INSTALLATIONS, BUILDING REGULATIONS - ROCK MINERAL WOOL:

- Insulation thickness to achieve the maximum permissible heat loss stated in the Building Regulations Part L Non Domestic Building Services Compliance Guide Northern Ireland Technical Booklet F2, and section 6 of the Scottish Non Domestic Technical Handbook.

Outside diameter of steel pipe (mm)	Thickness of rock mineral wool insulation (mm)					
Temperature of contents °C	≤95		96-120		121-150	
Surface emissivity	0.05	0.9	0.05	0.9	0.05	0.9
17	25	30	25	30	25	30
21	30	35	30	35	30	35
27	35	40	40	45	40	45
34	35	40	45	55	55	55
42	35	40	55	60	65	70
48	40	45	55	60	70	75
60	40	45	60	65	75	80
76	45	50	60	65	80	90
89	45	50	65	70	80	90
114	50	55	65	75	90	100
140	50	55	70	75	90	100
168	50	55	70	80	100	100
219	50	60	75	80	100	120
273	50	60	75	90	100	120

- Basis of calculation of thickness: Horizontal pipe at 75°C (LTHW) or 100°C (MTHW) or 125°C (HTHW) in still air at 15°C. Thermal conductivity calculated from the mean insulation temperature based on the fluid and air temperatures.
- Use this table for insulation thickness of copper or plastic pipework of the nearest equivalent outside diameter.

2315 NON-DOMESTIC HEATING INSTALLATIONS, BUILDING REGULATIONS - GLASS MINERAL WOOL:

- Insulation thickness to achieve the maximum permissible heat loss stated in the Building Regulations Part L Non Domestic Building Services Compliance Guide, Northern Ireland Technical Booklet F2 and section 6 of the Scottish Non Domestic Technical Handbook.

Outside diameter of steel pipe (mm)	Thickness of glass wool insulation (mm)					
Temperature of contents °C	≤95		96-120		121-150	
Surface emissivity	0.05	0.9	0.05	0.9	0.05	0.9
17	25	30	25	30	25	30
21	30	40	30	40	30	40
27	30	40	40	40	40	40
34	40	40	50	50	50	50
42	40	40	50	50	60	60
48	40	50	50	60	60	80
60	40	50	60	60	80	80
76	50	50	60	60	80	80
89	50	50	60	80	80	80
114	50	50	60	80	80	100
140	50	60	80	80	100	100
168	50	60	80	80	100	100
219	50	60	80	80	100	100
273	50	60	80	80	100	100

- Basis of calculation: Horizontal pipe at 75°C (LTHW),100°C (MTHW) or 125°C (HTHW) in still air at 15°C. Thermal conductivity calculated from the mean insulation temperature based on the fluid and air temperatures.
    - Use this tale for insulation thickness of copper or plastic pipework of the nearest equivalent outside diameter.

2327 NON-DOMESTIC HEATING INSTALLATIONS, ECA ENHANCED:

- The insulation manufacturer selected for a particular project should calculate the minimum required thicknesses of pipework insulation based on the actual conductivity of the product at the relevant temperature and the criteria on the ECA web site for an eligible installation using the methodology set out in BS EN ISO 12241 and the assumptions set out in Table C1 of BS 5422. The table below defines the maximum permissible heat losses to be used in the calculations.

Non-Domestic Heating Installations Maximum Permitted Heat Loss (W/m)			
Temperature	Low	Medium	High
	< 95°C	96-120°C	121-150°C
Outside Pipe Diameter (mm)			
17.2	7.78	10.57	13.27
21.3	8.42	11.25	14.06
26.9	9.05	12.06	15.02
33.7	9.86	13.04	16.07
42.4	10.83	14.12	17.34
48.3	11.42	14.80	18.09

60.3	12.61	16.22	19.62
76.1	14.12	17.88	21.41
88.9	15.28	19.20	22.87
114.3	17.51	21.66	25.53
139.7	19.72	23.99	27.98
168.3	22.34	26.63	30.69
219.1	26.61	31.15	35.25
273 & above	30.91	35.83	40.05

2330 DOMESTIC CENTRAL HEATING AND HOT WATER SYSTEMS - ROCK MINERAL WOOL:

- Insulation thickness to achieve the maximum permissible heat loss stated in the Building Regulations Part L Domestic Building Services Compliance Guide Northern Ireland Technical Booklet F1, and section 6 of the Scottish Domestic Technical Handbook.

Outside diameter of copper pipe (mm)	Domestic heating and hot water Thickness of mineral wool insulation (mm)	
Surface emissivity	0.05	0.9
17	-	-
22	20	20
28	20	25
35	20	25
42	20	25
54	20	25

- Basis of calculation of thicknesses: Horizontal pipe at 60°C (LTHW) in still air at 15°C. Thermal conductivity calculated from the mean insulation temperature based on the fluid and air temperatures.
- Mineral wool sections are not available for pipe outside diameters less than 17mm.
    - Use this table for insulation thickness for plastic pipework of the nearest equivalent outside diameter.

2331 DOMESTIC CENTRAL HEATING AND HOT WATER INSTALLATIONS, ECA ENHANCED:

- The insulation manufacturer selected for a particular project should calculate the minimum required thicknesses of pipework insulation based on the actual conductivity of the product at the relevant temperature and the criteria on the ECA web site for an eligible installation using the methodology set out in BS EN ISO 12241 and the assumptions set out in Table C1 of BS 5422. The table below defines the maximum permissible heat losses to be used in the calculations.

Domestic Heating & Hot Water Maximum Permitted Heat Loss (W/m)	
Temperature	60°C
Outside Pipe Diameter (mm)	
8	5.82
10	6.20
12	6.52
15	7.03
22	8.02

28	8.87
35	9.63
42	10.58
54	11.83

2456 INSULATION THICKNESS ON DUCTWORK, BUILDING REGULATIONS:

- Insulation thickness to limit heat gains and heat losses stated in the Building Regulations Part L Non Domestic Building Services Compliance Guide, Northern Ireland Technical Booklet F2 and section 6 of the Scottish Non Domestic Technical Handbook.

Material	Thickness of insulation (mm)					
	Warm air ductwork			Chilled air / dual purpose ductwork		
Surface Emissivity	Low (0.05)	Med (0.44)	High (0.9)	Low (0.05)	Med (0.44)	High (0.9)
Rock Mineral wool Ductwrap	40	40	40	50	60	70
Glass mineral wool	40	40	40	50	60	60
Phenolic foam	20	25	25	35	40	40
Nitrile rubber	32	37	40	51	60	62

- Basis:
  - Warm air ductwork - horizontal duct at 35°C, with 600 mm vertical sidewall in still air at 15°C.
  - Chilled air ductwork - horizontal duct at 13°C, with 600 mm vertical sidewall in still air at 25°C.
  - Thermal conductivity values calculated from the mean insulation temperature based on the fluid and air temperatures.
  - Thicknesses of mineral wool and phenolic foam are the nearest commercially available thickness to meet minimum requirements.
  - Thicknesses of nitrile rubber are minimum thicknesses.

2460 CONDENSATION CONTROL ON CHILLED AIR DUCTWORK - ROCK MINERAL WOOL:

- Insulation thickness for condensation control on ductwork carrying chilled air in ambient conditions: indoor still air temperature 25°C, relative humidity 80%, dew point temperature 21.3°C.

Minimum air temperature inside duct °C	Thickness of rock mineral wool insulation (mm)		
Surface emissivity	Low (0.05)	Medium (0.44)	High (0.90)
15	30	25	25
10	50	25	25
5	70	40	25
0	90	50	30

- Basis: Table 12 in BS 5422, thermal conductivity values calculated from the mean insulation temperature based on the fluid and air temperatures.
- All ductwork shall be insulated where were visible (i.e exposed ductwork) when the duct surface temperature is below the dew point of the air within the space served.

2461 CONDENSATION CONTROL ON CHILLED AIR DUCTWORK - GLASS MINERAL WOOL:

- Insulation thickness for condensation control on ductwork carrying chilled air in ambient conditions: indoor still air temperature 25°C, relative humidity 80%, dew point temperature 21.3°C.

Minimum air temperature inside duct °C	Thickness of glass mineral wool insulation (mm)		
Surface emissivity	Low (0.05)	Medium (0.44)	High (0.90)
15	25	25	25
10	40	25	25
5	50	40	25
0	50	50	40

- Basis: Table 12 in BS 5422, thermal conductivity values calculated from the mean insulation temperature based on the fluid and air temperatures.
- All ductwork shall be insulated where were visible (i.e exposed ductwork) when the duct surface temperature is below the dew point of the air within the space served.

2470 CONDENSATION CONTROL ON CHILLED AIR DUCTWORK - PHENOLIC FOAM:

- Minimum insulation thickness for condensation control on ductwork carrying chilled air in ambient conditions: indoor still air temperature 25°C, relative humidity 80%, dew point temperature 21.3°C.

Minimum air temperature inside duct °C	Thickness of phenolic foam insulation (mm)		
Surface emissivity	Low (0.05)	Medium (0.44)	High (0.90)
15	20	20	20
10	30	20	20
5	50	25	20
0	60	30	20

- Basis: Table 12 in BS 5422, thermal conductivity values calculated from the mean insulation temperature based on the fluid and air temperatures.

- All ductwork shall be insulated where were visible (i.e exposed ductwork) when the duct surface temperature is below the dew point of the air within the space served.

2475 CONDENSATION CONTROL ON CHILLED AIR DUCTWORK - CLOSED CELL FEF NITRILE FOAM:

- Minimum insulation thickness for condensation control on ductwork carrying chilled air in ambient conditions: indoor still air temperature 25°C, relative humidity 80%, dew point temperature 21.3°C.

Minimum air temperature inside duct °C	Nominal thickness of FEF Nitrile foam insulation (mm)	
Surface emissivity	low (0.05)	high(0.9)
15	12	6
10	21	11
5	31	17
0	40	22

- Basis: Table 12 in BS 5422, thermal conductivity values calculated from the mean insulation temperature based on the fluid and air temperatures.
- All ductwork shall be insulated where were visible (i.e exposed ductwork) when the duct surface temperature is below the dew point of the air within the space served.
- Thicknesses of nitrile rubber are minimum thicknesses.

2490# THICKNESS OF INSULATION TO BS 5422 FOR PROCESS PIPEWORK AND EQUIPMENT:

- Comply with the requirements of sections 4 and 10 and relevant annexes of BS 5422 and supply minimum thickness of insulation for services in accordance with relevant tables in BS 5422 to control heat loss or limit surface temperature.
    - Table 21 - Minimum insulation thickness for process pipework and equipment to control heat loss.
    - Table 22 - Minimum insulation thickness to control the surface temperature of a non-metallic surface with a surface emissivity of 0.90 and design cold face temperature of 59°C.
    - Table 23 - Minimum insulation thickness to control the surface temperature of a metallic surface with a surface emissivity of 0.05 and design cold face temperature of 50°C.
    - Table 24 - Minimum insulation thickness to control the surface temperature of a non-metallic surface with a surface emissivity of 0.90 and design cold face temperature of 50°C.

2495# THICKNESS OF INSULATION TO BS 5422 FOR REFRIGERATION PIPEWORK AND EQUIPMENT:

- To control heat gain and condensation, comply with the requirements of section 6 of BS 5422 and supply minimum thickness of insulation in accordance with relevant tables below and Annexes F and H in BS 5422.
    - Table 1 – Maximum permitted water vapour permeance in relation to plant temperature at an ambient temperature of +20°C (dry bulb).
    - Table 2 – Minimum insulation thickness for refrigeration applications to control condensation and control heat gain on a high emissivity outer surface (0.90) with an ambient temperature of +20°C and a relative humidity of 70%.

- Table 3 – Minimum insulation thickness for refrigeration applications to control condensation and control heat gain on a low emissivity outer surface (0.05) with an ambient temperature of +20°C and a relative humidity of 70%.
- Table 4 – Minimum insulation thickness for refrigeration applications to control condensation and control heat gain on a high emissivity outer surface (0.90) with an ambient temperature of +25°C and a relative humidity of 80%.
- Table 5 – Minimum insulation thickness for refrigeration applications to control condensation and control heat gain on a low emissivity outer surface (0.05) with an ambient temperature of +25°C and a relative humidity of 80%.

3000 WORKMANSHIP

3010 GENERAL:

- Install insulation in accordance with BS 5970.
- Carry out thermal insulation work using one of the scheduled firms employing skilled craftsmen conversant with class of work.
- In locations where insulation cannot be installed adequately after pipeline or ductline installation, pre-insulated sections shall be installed. Insulation to such sections shall be equivalent in thermal and physical properties to that specified for the remainder of the system including vapour barriers.
- Do not apply thermal insulation until installation has been fully tested and all joints proved sound.
- Ensure all materials are kept dry.
- Ensure all pipework surfaces are dry before the installation of thermal insulation.
- Insulate each unit separately. Do not enclose adjacent units together.
- Ensure there is clearance between insulated pipes.
- Application
    - Apply insulants, facings, coatings and protection strictly in accordance with manufacturer's instructions.
- Finish
    - Neatly finish joints, corners, edges and overlaps and, where possible, arrange overlaps to fall on blind side. Ensure overlaps are neat and even and parallel to circumferential and longitudinal joints.

3020 INSTALLATION OF FOIL FACED MINERAL WOOL INSULATION ON PIPEWORK:

- Ensure joints are close butted together. Secure overlaps with adhesive or matching class 'O' tape, a minimum of 50mm wide, on both longitudinal and circumferential butt joints. Insulate fittings to same standard as adjacent pipework and use mitred segments where necessary, taped as above.
- Where a vapour seal or fibre containment is required tape exposed insulation membrane and return to pipe surface.
- Where insulation abuts pipe support inserts that have integral vapour barriers seal using class 'O' foil tape to continue vapour barrier or containment.

3030 INSTALLATION OF FOIL FACED PHENOLIC FOAM INSULATION ON PIPEWORK:

- Ensure joints are close butted together. Secure overlaps with adhesive or matching class 'O' tape, a minimum of 50mm wide, on both longitudinal and circumferential butt joints. Insulate

fittings to same standard as adjacent pipework and use mitred segments where necessary, taped as above.

- Before phenolic foam sectional insulation is applied, ensure that all pipework is clean, dry and free of any debris or corrosive substances such as excess soldering flux, building materials.
- Installation shall be by a contractor approved by the manufacturers strictly in accordance with the manufacturer's installation instructions.
- All exposed edges of phenolic foam insulation shall be sealed to the surface being insulated with a suitable vapour sealing mastic.

3050 INSTALLATION OF CLOSED CELL NITRILE RUBBER INSULATION ON PIPEWORK:

- Install closed cell nitrile rubber in accordance with manufacturer's recommendations.
- Check installation procedure when closed cell nitrile rubber is to be installed on stainless steel pipework.

3060 INSTALLATION OF FOIL FACED RIGID OR SLOTTED PHENOLIC INSULATION ON DUCTWORK:

- Secure the insulation with adhesive in accordance with manufacturer's recommendations. Use insulation hangers that are fit for purpose and in accordance with thermal insulation and insulation hanger manufacturers.
- Cut slabs so that the top and bottom pieces overlap the sides. Seal joints and pin penetrations using 100mm wide class 'O' aluminium foil tape.
- Where cut outs for test holes, etc occur tape over insulation membrane and return to the duct surface.
- Where insulation abuts duct support inserts that have integral vapour barriers seal using class 'O' foil tape to continue vapour barrier.

3070 INSTALLATION OF FOIL FACED FLEXIBLE DUCTWORK INSULATION:

- Secure the insulation with adhesive in accordance with manufacturer's recommendations. Use insulation hangers spaced at maximum 300mm centres on the underside of rectangular and flat oval ducts.
- Seal joints and pin penetrations using 100mm wide class 'O' aluminium foil tape. Where cut outs for test holes, etc occur tape over insulation membrane and return to the duct surface.
- Where insulation abuts duct support inserts that have integral vapour barriers seal using class 'O' foil tape to continue vapour barrier.

3080 INSTALLATION OF FOIL FACED LAMELLA ON DUCTWORK:

- Secure the insulation in accordance with manufacturer's recommendations. Use insulation hangers spaced at maximum 300mm centres on the underside of rectangular and flat oval ducts.
- Seal joints and pin penetrations using 100mm wide class 'O' aluminium foil tape. Where cut outs for test holes, etc occur tape over insulation membrane and return to the duct surface.
- Where insulation abuts duct support inserts that have integral vapour barriers seal using class 'O' foil tape to continue vapour barrier.

3090 INSTALLATION OF INSULATION ON TANKS:

- Fit insulation so that two opposite pieces overlap the sides. Bond insulation to the tank with adhesive, applied in accordance with the manufacturer's recommendations. Closely butt together all slabs and seal joints with a matching self-adhesive tape 100mm wide.

3100 INSTALLATION OF MINERAL WOOL INSULATION ON VESSELS:

- Cut Lamella to length to wrap around duct with an additional 75mm to form an overlap. Remove insulation from facing of overlap together with dust, and seal overlap with adhesive in accordance with manufacturer's instructions. Butt joints closely together and seal with matching self-adhesive tape at least 100mm wide.

3110 INSTALLATION OF PHENOLIC FOAM INSULATION ON VESSELS:

- Use pre-formed segments or pre-slotted foil faced insulation to fit the diameter of the vessel, laid with staggered joints. Vapour seal the joint faces. Use jointing compound to fill and seal joints around protrusions.
- Do not use wire to secure insulation.
- Secure insulation segments up to 3500mm outside insulation diameter with filament tape 38mm wide at 300mm centres.
- Secure insulation segments over 3500mm outside insulation diameter with aluminium banding.
- Finish as manufacturer's recommendations.

3120 INSTALLATION OF POLYISOBUTYLENE (PIB) PROTECTION:

- Wrap pipework and fittings, ductwork or tanks and vessels with PIB sheeting lapped at every joint by at least 50mm. Solvent weld joints and support with banding in accordance with manufacturer's
- Arrange joints to shed water and prevent the ingress of water.

3125 INSTALLATION OF MULTI-LAYERED LAMINATE:

- Install laminated foil/film protection, in accordance with manufacturer's instructions.
- Installation may be either factory pre-applied or applied in-situ.
- Ensure all surfaces are dry and clean, free from dust, oil and grease/silicone.
- Arrange joints to give water shed with the lap facing down.

3130A INSTALLATION OF SHEET METAL FINISH ON PIPEWORK:

- Secure insulation with metal bands at each end of section and at maximum centres of 450mm. Form sheet metal to fit tightly over the outer circumference of insulation with a longitudinal overlap of at least 40mm. Secure the outer part of overlap with self tapping screws or rivets at centres of not more than 150mm. Not on pipes with vapour barrier; or metal bands of same material.
- Ensure circumferential overlaps are at least 50mm, secured with self tapping screws or rivets. Make provision to accommodate expansion and contraction at intervals. Ensure all joints are lapped to shed liquids and seal all joints exposed to weather or spillage. Cover all bends and fittings with matching sheet metal, tailored to fit and sealed as appropriate. Fit pre-insulated, purpose-designed boxes to valves, flanges, etc.

3140A INSTALLATION OF SHEET METAL FINISH ON DUCTWORK, TANKS AND VESSELS:

- Form sheet metal to fit tightly over the insulation with a longitudinal overlap of at least 40mm. Secure the outer part of overlap with self tapping screws or rivets at centres of not more than 150mm. Not on vapour sealed ducts; or metal bands of same material.
- Ensure circumferential overlaps are at least 50mm, secured with self tapping screws or rivets. Make provision to accommodate expansion and contraction at intervals. Ensure all joints are lapped to shed liquids and seal all joints exposed to weather or spillage. Cover all bends and fittings with matching sheet metal, tailored to fit and sealed as appropriate.

3150 INSTALLATION OF CANVAS PROTECTION:

- Cover the whole with 130g (minimum) canvas with at least 50mm overlaps. Seal joints.
- Give two coats of class 'O' polymer solution. Fit aluminium bands where indicated.

3160 INSTALLATION OF ROOFING FELT PROTECTION:

- Apply directly to insulating material with an overlap of at least 50mm on all joints, made to shed water. Secure in position with galvanized wire netting, of 1mm x 25mm mesh. Finish with two coats of black bituminous paint.

3170 INSTALLATION OF ALUMINIUM SHEETING PROTECTION:

- Secure lapped joints (at least 40mm) by means of pop rivets at a maximum spacing of 150mm. For cold piping use matching aluminium straps at maximum spacing of 225mm. On piping operating below ambient temperature seal all joints against moisture. For external use make joints shed water and use sheets with treated surface.
- Where `lockform' seams are used submit proposals for dealing with surfaces curved in three dimensions.

3180 INSTALLATION OF ALUMINIUM-ZINC COATED STEEL PROTECTION:

- Install aluminium-zinc coated steel protection, in accordance with manufacturer's instructions.

3190 INSTALLATION OF RIGID PVC PROTECTION:

- Apply rigid PVC sheet and pre-formed fittings directly to insulation with an overlap of at least 40mm on longitudinal and circumferential joints. Secure longitudinal laps with plastic rivets at 150mm centres.
- Ensure rigid PVC is not installed in contact with heat sources.

3210 FLANGES AND VALVES:

- Cut back to allow removal of bolts and nuts, finish with neat bevel or use end caps.
- Where boxes are used fit over insulation on adjacent piping. Ensure operation of valve remains unimpaired with box in place.

3230A INSTALLATION WHERE INSULATION IS CARRIED THROUGH PIPELINE SUPPORT:

- For load bearing insulation, carry through insulation and finish.
- For non-load bearing insulation on hot pipework close butt to a section of load bearing finished material minimum 100mm long.
- For non-load bearing insulation on cold pipework, close butt to high density phenolic foam pipe supports. Ensure the vapour barrier is maintained.

3230B INSTALLATION WHERE CLOSED CELL INSULATION IS CARRIED THROUGH PIPELINE SUPPORT:

- For load bearing insulation, carry through insulation and finish.
- For non-load bearing insulation on hot pipework up to 120°C, close butt to a high density phenolic or polyisocyanurate pipe support.
- For non-load bearing insulation on cold pipework, close butt to high density phenolic foam pipe supports.
- Ensure the vapour barrier is maintained.

3250 INSTALLATION WHERE INSULATION IS CARRIED THROUGH DUCTWORK SUPPORT:

- Provide insulation between duct and support using high density phenolic foam strips. Butt insulation to spacer and carry over finish by 40mm and tape joint. Provide a sheet metal protecting sleeve. Load bearing materials must have a suitable compressive strength for the applied load.

3260 LIQUID VAPOUR BARRIERS:

- Apply vapour seal solution evenly by brush in accordance with manufacturer's instructions; use solution which dries to a colour distinctive from insulating material.

3270 INTEGRITY OF VAPOUR BARRIERS:

- Where a vapour barrier is indicated ensure its integrity throughout. Repair immediately any damage to vapour barriers and where such barriers have been applied off site, repair to manufacturer's instructions. Where aluminium sheeting is used for protection, submit proposals for securing sheeting without impairing the integrity of the vapour seal for approval.

Y51 - TESTING AND COMMISSIONING OF MECHANICAL SERVICES

2010 PRESSURE TESTING - GENERAL:

- Comply with procedures given in TR/6 Site pressure testing of pipework. Building Engineering Services Association. Guide to good practice. Ensure safety precautions detailed in, HSE Guidance Note GS4 Safety requirements for pressure testing, are adopted.
- Provide a blanked connection to accommodate a check gauge in addition to the accurate gauge fitted to section under test.
- Test concealed or buried pipework before any permanent covering is applied.
- Advise appropriate personnel, in advance, of the time pressure tests may be witnessed.

2015 PRESSURE AND LEAKAGE TESTING - BUILDERS' WORK SHAFTS, VOIDS, ENCLOSURES AND FLOOR PLENUMS:

- Ensure all builder's work shafts, voids and enclosures are pressure and leakage tested, and signify acceptance of standard and integrity of construction, prior to pre-commissioning of engineering installations.
- Pressure test floor plenums / voids using a specialist building airtightness tester ATTMA registered to level 2, using ATTMA standard TSL2 and BSRIA BG 65/2016 - Floor Plenum Airtightness Guidance and Testing Methodology.
- Maximum value of plenum air leakage to be 0.7l/s/m^2 of floor area at a test pressure of 50Pa or 5% of the air volume flow rate supplied to the plenum.
- Maximum raised access floor leakage to be 1.0l/s/m^2 of floor area without carpets, at a test pressure of 50Pa.

2020 PRESSURE TESTING - WATER CIRCULATING AND SUPPLY SYSTEMS

- Carry out hydraulic pressure testing as described in TR/6 Site pressure testing of pipework. Building Engineering Services Association. Guide to good practice. Test section by section for one hour, as the work proceeds and prior to application of thermal insulation as follows
    - Operating gauge pressure less than 3.5 bar, test gauge one and a half times the maximum working pressure.
    - Operating gauge pressure 3.5 - 7.0 bar, test gauge pressure twice the maximum working pressure.
    - Operating gauge pressure greater than 7.0 bar, test gauge pressure 14.0 bar or one and a half times the maximum working pressure, whichever is the greater.

2030# PRESSURE TESTING - UNDERGROUND PIPEWORK:

- Test to a gauge pressure not less than twice the operating pressure for 1 hour.
- Test to a gauge pressure twice the operating pressure or 7 bar, whichever is the greater, for 4 hours.

2040 PRESSURE TESTING - WATER MAINS:

- Test to Local Authority requirements. Ensure the provisions laid down in: TR/6 Site pressure testing of pipework. Building Engineering Services Association. Guide to good practice; for testing underground CWS mains are carried out.

2050 PRESSURE AND FLOW TESTING - FIRE RISERS:

- Undertake static pressure tests followed by flow and pressure tests in accordance with BS 9990. Demonstrate to Fire Brigade when tests are satisfactory.

2055# PRESSURE TESTING - REFRIGERANT PIPEWORK:

- Test refrigerant pipework using the strength test procedure as detailed in Clause R6.4 of the CIBSE Commissioning Code R: 2002.
- Test refrigerant pipework using the leak test procedure as detailed in Clause R6.5 of the CIBSE Commissioning Code R: 2002.
- Test refrigerant pipework using the deep vacuum test method as detailed in Clause R6.6 of the CIBSE Commissioning Code R: 2002.

2065 PRESSURE TESTING - OIL PIPEWORK:

- Test oil pipework installation in accordance with relevant part of BS 5410 to suit the application and TR/6 Site pressure testing of pipework. Building Engineering Services Association. Guide to good practice.

2075 TESTING CONDENSE AND OVERFLOW SYSTEMS:

- Test condensate drainage systems from cooling coils and any overflow pipework / drainage pipework from plant in accordance with BS EN 12056-2 and TR/6 Site pressure testing of pipework. Building Engineering Services Association. Guide to good practice.

2080 PRESSURE TESTING - SOIL, WASTE, VENTILATION, ANTI-SYPHON AND RAINWATER PIPEWORK:

- Test section by section as the work proceeds and subsequently on completion with all sanitary fittings fixed and working. Submit systems to two separate tests: Air test and Hydraulic Performance test in accordance with BS EN 12056-2.

2090 PRESSURE TESTING - UNDERSLAB DRAINAGE:

- For systems inside building comply with relevant parts of BS EN 12056.
- Test section by section as the work proceeds and subsequently after completion of backfilling and compaction to the satisfaction of the Engineers and the Local Authority.
- Individually test sections which will be permanently embedded in the structure or concealed in ducts or voids.
- Submit sections to two separate tests: Water Test and Test for Straightness and Obstruction in accordance with BS EN 752 for drainage outside buildings.

3020 COMMISSIONING CODES:

- Carry out commissioning of installations in accordance with the procedures, checks and tolerances given in the BSRIA Application Guides for water systems and air systems to achieve the standards set in the CIBSE Commissioning Codes.

3025 SEASONAL COMMISSIONING:

- Provide appropriately qualified personnel and all necessary equipment and materials to execute the seasonal commissioning works. The same organisation / team that carried out the original construction works shall undertake the seasonal commissioning.
- A schedule of suitable working periods and essential services to be maintained during any work will be provided by the building operator.
- A programme for the works shall be provided at least 1 month prior to the start date. This should account for any phased hand overs, cause as little disruption as possible and ensure essential services are maintained.
- The works shall comply with all statutory and client specific Health and Safety requirements.
- Any performance deficiencies found during seasonal commissioning shall be corrected.
- All seasonal commissioning shall be carried out in accordance with the project commissioning specification, an approved method statement, manufacturers' guidelines and the day-to day operational requirements of the building users.
- Record all seasonal commissioning works and after completion of the works update all building documentation including O&M manuals, Building Manual, Building Log book, Building User Guide and the Building Information Model (BIM). Any changes made to the systems during the works shall be clearly identified.

3030 COMMISSIONING WATER DISTRIBUTION SYSTEMS:

- Preliminary checks
  - Carry out checks and procedures as detailed in CIBSE Commissioning Code W. Ensure system is statically complete as defined in Section 4 of BSRIA Guide BG 2/2010 - Commissioning Water Systems.
  - Use pre-commissioning checklist from BSRIA Guide BG 2/2010.
- Setting to work and regulation
  - Set to work and regulate water distribution systems in accordance with CIBSE Commissioning Code W and BSRIA Guide BG 2/2010.
- Measurement
  - Use instruments for measurement detailed in BSRIA Guide BG 2/2010.

3040 COMMISSIONING AIR DISTRIBUTION SYSTEMS:

- Preliminary checks
  - Carry out checks and procedures as detailed in BSRIA Guide BG 49/2015 Commissioning Air Systems.
  - Use pre-commissioning checklist in BSRIA Guide BG 49/2015.
- Setting to work and regulate

    - Set to work and regulate constant and variable flow air distribution systems in accordance with CIBSE Commissioning Code A and BSRIA Guide BG 49/2015.
- Measurement of air flow
    - Use instruments for measurement and methods of measurement detailed in BSRIA Guide BG 49/2015 and CIBSE Commissioning Code A.
- Undertake tests and checks to ventilation and air conditioning systems generally in accordance with BS EN 12599 in order to verify the fitness for purpose of the installed systems before, during and after handover. Method statement to include relevant checklists from BS EN 12599.

3050 COMMISSIONING BOILER PLANT:

- Follow the procedures laid down for carrying out Preliminary Checks and Start Operation in accordance with CIBSE Commissioning Code B and manufacturers instructions.
- Apparatus and Instruments
    - Use Apparatus and Instruments detailed in CIBSE Commissioning Code B, Appendix BA1. Apply tolerances defined in Appendix BA1.

3060 COMMISSIONING REFRIGERATING SYSTEMS:

- Follow the procedures given for use and handling of refrigerants, pressure and leak testing, evacuation and dehydration, charging and lubrication of refrigerating systems in CIBSE Commissioning Code R and manufacturer's instructions.
- Pre-commissioning:
    - Carry out the procedures for pre-commissioning detailed in CIBSE Commissioning Code R, Section R5.
- Combined pressure and leak testing:
    - Carry out the procedures for combined pressure and leak testing, including refrigerant charging, detailed in CIBSE Commissioning Code R, Section R6.
- Setting to work and adjusting
    - Carry out the procedures for setting to work and adjusting detailed in CIBSE Commissioning Code R7.
- Absorption Systems.
    - Carry out the procedures for Preliminary Checks, Testing and Charging, and Setting to Work and adjusting detailed in CIBSE Commissioning Code R, Section R10.
- Apparatus and Instruments
    - Use Apparatus and Instruments detailed in CIBSE Commissioning Code R, Section R8. Apply tolerances defined in Section R8.6.

3070 COMMISSIONING AUTOMATIC CONTROL SYSTEMS:

- Carry out commissioning of Automatic Control Systems in accordance with Manual prepared by the controls equipment manufacturer. Carry out the Checking and Setting-Up procedure detailed in the CIBSE Commissioning Code C, Section C1.
- Measurement

- Carry out measurements in accordance with CIBSE Commissioning Code C, Appendix C2.1.

3090A INSTRUMENTS AND GAUGES:

- Ensure instruments are correctly calibrated. Record details of instruments on record sheets.
- Submit evidence of correct calibration of instruments to be used in connection with commissioning and testing.

3100A AIR SYSTEMS COMMISSIONING RECORDS TO BSRIA BG 49/2015:

- Keep a systematic record of commissioning results and distribute as indicated.
- For air systems
  - Use record sheets as described in BSRIA Guide BG 49/2015 Commissioning Air Systems.

3100B WATER SYSTEMS COMMISSIONING RECORDS TO BSRIA GUIDE BG 2/2010:

- Keep a systematic record of commissioning results and distribute as indicated.
- For water systems
  - Use record sheets as detailed in BSRIA Guide BG 2/2010 Commissioning Water Systems.

3110 BMS COMMISSIONING - CONTROL SYSTEM SPECIFICATION DETAILS REQUIRED FOR COMMISSIONING:

- Ensure that the following information is supplied to the commissioning engineer:
  - A network schematic providing a record of the overall control system architecture.
  - Schematics of the systems to be controlled indicating the location of sensors and actuators.
  - A written description of the configured control strategies.
  - Control strategy logic diagrams in the form of logic flow charts.
  - Set-points and other control settings such as initial default parameters for control loops relating to the control strategies.
  - Criteria relating to control accuracy and stability.
  - A points list including digital inputs/outputs and analogue inputs/outputs.
  - Control panel drawings.
  - BMS operator workstation graphics and associated point data displaying monitored conditions.
  - Trend logging archiving requirements and alarm routing.
  - The scope of operational and specified functionality of management software, e.g. utility monitoring and targeting software.
  - Functional requirements of any occupant interfaces.
  - Details of any hard-wired interfaces from, or to, other control devices.
  - Functionality and scope of data to be transferred over any gateway for use as part of an integrated system.
  - Functional profiles for any direct interoperability integration.
- Ensure that the following is included in the BMS commissioning specification:-
  - A clear description of the division of responsibility between the various parties.
  - Off-site and on-site pre-commissioning procedures.

- On-site commissioning procedures.
- Requirements for assistance to air and water balancing testing (e.g. opening and closing control valves) and other plant tests where the controls need to be overridden.
- A requirement for any point-by-point verification of correct operation.
- Requirements for evaluation of control loop performance/loop tuning.
- Requirements for the BMS operator workstation for assistance in the commissioning of plant.
- Arrangement for the management of delays.
- Phased completion requirements.
- Requirements for demonstration/witness testing on the basis of a percentage of points or on a point-by-point basis. Ensure that the witnessing requirement includes the identification of those responsible.
- Requirement for software/configuration data back-up.
- Requirement for, and involvement in, any complete system and sub-system performance testing.
- Requirement for system documentation.
- Requirement for operator training requirements.
- Requirement for post occupancy checks.

3120 BMS COMMISSIONING - PRE-COMMISSIONING:

- Ensure that as much pre-commissioning work as possible is performed off-site:
- Ensure that the following is followed:
    - Pre-commissioning requirements

Pre-commissioning action	Pre-commissioning off-site
Control application software	Yes (final commissioning on-site)
User interface software	Yes (final commissioning on-site)
Control panels	Yes (final commissioning on-site)
Terminal units (fan coil units, etc)	Yes (final commissioning on-site)
Wiring	No
Communications network	No
Sensors	No
Actuators	No
Integration gateways	Partial

- Ensure that a record of all settings, set-points and offsets are maintained throughout the pre-commissioning period.
- Ensure that all final physical adjustments to the field devices are indelibly marked.
- Ensure that all packaged plant interfaced with the BMS is fully tested and commissioned by the manufacturer or installer.
- Ensure that the BMS is pre-commissioned in accordance with the following requirements of CIBSE Code C (Commissioning of automatic control systems).
    - CIBSE Code C automatic control systems pre-commissioning requirements

Pre-commissioning action	CIBSE Code C section reference
Control applications software	C5.2
Control panels	C5.3
Wiring	C5.4

Communications networks	C5.5
Sensors	C5.6
Actuators and valves	C5.7
Digital inputs/outputs	C5.8
Pneumatic actuation with microprocessor control	C5.9
Field control devices	C5.10

3130A BMS COMMISSIONING - PLANT READY FOR CONTROL SYSTEM COMMISSIONING:

- Confirm that the following plant commissioning has been performed before commencing the final BMS commissioning:
- Water systems
    - The system is cleaned and flushed to remove any debris.
    - All regulating, isolating and control valves in place and operating correctly.
    - That all flow measuring devices are in place and in the correct location for accurate measurement (including pressure tappings).
    - The system is vented.
    - That the proportional balancing is completed to obtain the branch flow rates in the correct ratio to each other (or through the use of and setting of self-balancing valves).
    - That the pump flow rate has been adjusted to provide the specified flow rate.
- Air systems
    - Debris has been removed from the air distribution system.
    - That dampers are in the correct location and fully functional.
    - That fire/smoke dampers open.
    - Test holes have been drilled and sealed with removable plugs.
    - That in-situ flow measuring devices have been installed.
    - Ductwork air leakage testing has been performed (if specified).
    - Completion of proportional balancing of regulating dampers so that terminals share the air flow in the correct proportions.
    - Regulation of the fan(s) to provide the specified flow rate.
- Packaged equipment
    - Ensure that plant and controls have been fully commissioned and are functional, ready for integration with other plant/systems.
    - That control equipment inputs/outputs are in the specified format for connection to the main control system.
- Confirm that the plant is commissioned in accordance with:
    - Air distribution systems, CIBSE Code A
    - Boiler plant, CIBSE Code B
    - Refrigeration systems, CIBSE Code R
    - Water distribution systems, CIBSE Code W
    - BSRIA Guide BG 49/2015 Commissioning Air Systems
    - BSRIA Guide BG 2/2010 Commissioning Water Systems

3140 BMS COMMISSIONING - CONTROL SYSTEM REQUIREMENTS FOR PLANT COMMISSIONING:

- Ensure that the BMS is pre-commissioned to allow the building services plant to operate under "manual" running conditions.
- Ensure that the control valves can be manually set in their fully open position to allow the balancing of pipework flows.
- Ensure that dampers can be manually opened to allow the commissioning of air systems.

3150 BMS COMMISSIONING:

- Ensure that the BMS is commissioned in accordance with the following requirements of CIBSE Code C (Commissioning of automatic control systems).
    - Control strategy checking - C6.2
    - Checking procedures for basic control functions - C6.3
    - Lighting controls - C6.4
    - Operator workstations - C6.5
    - Occupant interfaces - C6.6
    - Communication networks - C6.7
    - Integrated systems - gateways - C6.8
    - Integrated systems - direct interoperability - C6.9
    - Integration with fire detection systems - C6.10
    - Security systems - C6.11
    - Interruption of electrical power supplies - C6.12
    - Valves - C7.1
    - Dampers - C7.2
    - Fans - single speed - C7.3
    - Fans - variable speed - C7.4
    - Pumps - C7.5
    - Terminal units - C7.6
    - VRF systems - C7.7
    - Cooling coils - C7.8
    - Chilled water dehumidification coil - C7.9
    - LTHW heating coils - C7.10
    - Electric heater barriers - C7.11
    - Humidifier, steam and atomised spray types - C7.12

4000 PERFORMANCE TESTING

4010 SYSTEM PERFORMANCE TESTING / DEMONSTRATIONS:

- Demonstrate the performance and control sequence, including the operation of all safety devices of installations including single, standby, multi-duty plants and systems, and of plants specified for future use.

4015 TESTING OF RESIDENTIAL VENTILATION SYSTEMS:

- Demonstrate the performance of residential ventilation systems through performance testing and installation checks in accordance with BS EN 14134.

- Comply with the best practice requirements of BSRIA BG 46/2015 Domestic Ventilation Systems - A guide to measuring air flow rates, for measurement of air flow rates use the unconditional method.

4020A ENVIRONMENTAL TESTS, ARTIFICIAL LOADS:

- Carry out environmental testing to prove the performance of the systems.
- Apply artificial loads in the spaces to be tested including sensible and later heat emitters or provide test arrangements to simulate the full range of operating conditions and duties.

4020B ENVIRONMENTAL TESTS, AMBIENT AIR QUALITY

- Carry out environmental testing to prove the performance of the systems.
- Carry out ambient air quality tests in accordance with BS EN 13528-1, BS EN 13528-2 and BS EN 13528-3.

4030 RECORDERS:

- Provide and maintain on free loan portable seven day space temperature and relative humidity recorders, as indicated, together with adequate charts.

Y52 - VIBRATION ISOLATION MOUNTINGS

1010 DESIGN INTENT:

- Supply equipment indicated to ensure that vibration from equipment is not transmitted to building, other supporting structure, pipework or ductwork.

1020 SPRING ANTI VIBRATION MOUNTINGS:

- Select spring mounts with an overload capacity of 50%, for metal springs the outside diameter should be at least 75% of operating height. Permanently identify individual mounts with their load capacity.

1040 LOCKING FACILITY:

- Where indicated, provide lockable levelling device.

2000 PRODUCTS/MATERIALS

2010A SYNTHETIC MATERIAL CONFIGURED MAT MOUNTINGS:

- Provide configured mat mountings manufactured from neoprene or composite fibre/synthetic rubber.
- Where mats are stacked, bond 1mm steel sheet thickness between each pad without filling voids.

2010B NATURAL RUBBER CONFIGURED MAT MOUNTINGS:

- Provide configured mat mountings manufactured from natural rubber.
- Where mats are stacked, bond 1mm steel sheet thickness between each pad without filling voids.

2010C HIGH TEMPERATURE CONFIGURED MAT MOUNTINGS:

- Provide configured mat mountings manufactured from high temperature synthetic rubber.
- Where mats are stacked, bond 1mm steel sheet thickness between each pad without filling voids.

2010D RESILIENT MAT MOUNTINGS:

- Provide a minimum of 20mm resilient mat and sheet of 1.6 mm steel for incorporation in cast in situ base, unless otherwise shown on Drawings.

2010E PAD MOUNTINGS:

- Provide pad mountings manufactured from composite synthetic rubber.

2020A SYNTHETIC RUBBER TURRET COMPRESSION MOUNTINGS:

- Provide turret compression mountings fabricated from synthetic rubber between two steel plates.
- Protect the metal from corrosion by painting and fix friction pads to top and bottom. Provide bolt holes to allow fixing.

2020B NEOPRENE TURRET COMPRESSION MOUNTINGS:

- Provide turret compression mountings fabricated from neoprene between two steel plates.
- Protect the metal from corrosion by painting and fix friction pads to top and bottom. Provide bolt holes to allow fixing.

2030 SPRING COMPRESSION MOUNTINGS:

- Provide spring compression mountings comprising high strength low stress helical spring capped with steel pressure plate, on resilient base pad, mounted on pre-drilled base for bolting down, and enclosed with cap. Protect metal from corrosion.

2040 CAPTIVE SPRING MOUNTINGS:

- Provide captive spring mountings comprising high strength low stress helical spring designed to achieve horizontal and vertical snubbing.
- Mount spring on pre-drilled base plate for bolting down and protect against corrosion. Supply complete with levelling screw.

2050# TURRET COMPRESSION HANGERS:

- Design and construct hanger box from steel (minimum thickness 1.6mm) complete with hole for suspension rod and enlarged lower hole for drop rod to equipment.

2060 SPRING COMPRESSION HANGERS:

- Provide spring compression hangers comprising high strength low stress helical spring capped with steel pressure plate, on resilient base pad, mounted within hanger box.
- Design and construct hanger box from steel (minimum thickness 1.6mm) complete with hole for suspension rod and enlarged lower hole for drop rod to equipment.

2070A SYNTHETIC RUBBER HANGERS, COMBINED TURRET/SPRING COMPRESSION:

- Provide turret/spring compression hangers with turret fabricated from synthetic rubber and high strength low stress helical spring capped with steel pressure plate, on resilient base pad, incorporated within hanger box.
- Design and construc hanger box from steel (minimum thickness 1.6mm) complete with hole for suspension rod and enlarged lower hole for drop rod to equipment.

2070B NEOPRENE HANGERS, COMBINED TURRET/SPRING COMPRESSION:

- Provide turret/spring compression hangers with turret fabricated from neoprene and high strength low stress helical spring capped with steel pressure plate, on resilient base pad, incorporated within hanger box.
- Design and construct hanger box from steel (minimum thickness 1.6mm) complete with hole for suspension rod and enlarged lower hole for drop rod to equipment.

2080 HORIZONTALLY RESTRAINED SPRING MOUNTINGS:

- Provide horizontally restrained spring mountings comprising high strength low stress helical spring capped with steel pressure plate, on resilient base pad, mounted within hanger box.
- Design and construct hanger box from steel (minimum thickness 1.6mm) complete with holes for installing across connection. In addition supply synthetic rubber or neoprene snubber as a horizontal buffer.

2090A CONCRETE/STEEL FORMWORK INERTIA BASES:

- Provide purpose built inertia bases constructed using welded steel frame formwork containing concrete reinforced with 12mm minimum diameter bars at 100mm maximum centres, 35mm above the bottom of the base; and mounted on spring compression mountings.

2090B WELDED STEEL FRAME INERTIA BASES:

- Provide purpose built inertia bases constructed using welded steel frame mounted on spring compression mountings.

2100 VIBRATION ISOLATION HOSES:

- Provide flexible hose couplings for connecting pipework comprising nylon fabric or steel mesh carcass with waterproof cover and internal lining of material to suit fluid conveyed, temperatures and pressures indicated.

2110A NATURAL CORKWOOD PIPEWORK NOISE VIBRATION ISOLATION:

- Incorporate within pipework support ring purpose made isolators manufactured from natural corkwood of density 160 kg/cubic metre, impregnated with fungicide, individually bound with steel strip not more than half depth of isolator.

2110B RECONSTITUTED CORKWOOD PIPEWORK NOISE VIBRATION ISOLATION:

- Incorporate within pipework support ring purpose made isolators manufactured from resin bonded reconstituted soft corkwood granules, of density 100 kg/cubic metres.

2110C RUBBER MATTING PIPEWORK NOISE VIBRATION ISOLATION:

- Incorporate within pipework support ring purpose made isolators manufactured from rubber matting.

2120A SPONGE FOAM PIPE WALL AND RISER SEALS:

- Provide pipe sleeves, minimum length 300mm, with minimum 25mm dense sponge foam lining bonded internally.

2120B MINERAL FIBRE PACKING PIPE WALL AND RISER SEALS:

- Provide pipe sleeves, minimum length 300mm, with minimum 52mm mineral fibre packing lining bonded internally.

3000 WORKMANSHIP

3040 HORIZONTALLY RESTRAINED SPRING MOUNTINGS:

- Ensure snubbers for limiting excessive movement are installed out of contact during normal operation.

Y54 - IDENTIFICATION - MECHANICAL

1010 REQUIREMENTS:

- Identify all pipework, ductwork, equipment, appliances and ancillaries comprising the various systems.

1020 NEW SYSTEMS:

- Comprehensively label and colour code throughout works as indicated.

1040 COLOURS:

- As indicated to colour ranges given in BS 381C and BS 4800.

1045 PERFORMANCE AND DURABILITY:

- Ensure durability of identification for safety purposes is to BS ISO 17398.

2000 PRODUCTS/MATERIALS

2010 PIPEWORK IDENTIFICATION:

- Standards - Colour code and label to BS 1710.
- Primary Identification
    - Apply colour bands, 300mm wide, to each pipe at least
        - Once in every room or enclosed area.
        - At intervals not exceeding fifteen metres.
        - At every junction.
        - At every valve.
        - At every inspection and access position into service shafts, false ceilings, bulkheads etc.
- Secondary Identification
    - Apply colour bands, 50mm wide, and superimpose a legend identifying circuit, direction of fluid or gas flow, nominal pipe bore and, where appropriate, fluid or gas pressure.
- Legends
    - Apply to colour bands by transfers of an approved type.

2020 DUCTWORK IDENTIFICATION:

- Standards
    - Generally colour code and label to BESA DW/144.
- Primary Identification

- Apply colour bands, 300mm wide, to each duct at least
- Once in every room or enclosed area.
- At intervals not exceeding fifteen metres.
- At every junction.
- At every damper.
- At every inspection and access position into service shafts, false ceilings, bulkheads etc.

- Secondary Identification
  - For ducts with longest side or diameter up to and including 225mm. Paint colour bands 50mm wide and superimpose legends.
  - For ducts with longest side or diameter over 225mm. Paint or apply transfers to identification triangles, or triangular plates. Superimpose or incorporate legends.
- Triangular Plates
  - Attach to buckle bands or stool pieces and fix to ducting, with apex indicating direction of airflow. Submit details of plates and fixings for approval before painting and marking. Use equilateral triangle of side 150mm minimum.
- Legends
  - Apply transfers of an approved type to colour bands or triangles or triangular plates. Identify floor and space served, associated equipment reference and direction of airflow.

2030# PLANT AND EQUIPMENT IDENTIFICATION:

- Standards
  - Identify each item of equipment by name and, where appropriate, by agreed reference characters. Provide colour identification as called for in work sections and, in all cases, colour fire fighting equipment red.
- Identification Colours
  - Use primary and secondary identification colours of associated system.
- Plates
  - Use rectangular metal or laminated plastic, securely fixed to each item of equipment.
- Legends
  - Engrave plates with an approved text. Incorporate operating duty of equipment where this is not incorporated in other labelling.

2035 GRAPHICAL SYMBOLS FOR USE ON EQUIPMENT IN ACCORDANCE WITH BS EN 80416:

- Graphical symbols for use on equipment to be created and applied in accordance with BS EN 80416-1, BS EN 80416-2, BS EN 80416-3.

2040 VALVE AND COCK IDENTIFICATION:

- Standards
  - Identify each valve, cock, stop valve, air vent, drain cock etc. with disc engraved with numerical reference. Except where exposed in occupied areas.

- Identification Colours
    - Use primary and secondary identification colours of associated system for painted or self colour discs.
- Discs
    - Securely attach metal or laminated plastic discs, minimum diameter 35mm, to each item.
- Legends
    - Engrave discs with permanent characters, minimum height 6mm.
- Incorporate in operating instructions relating to regulating valves and flow measuring equipment, details of flow rate, pressure differential and setting, as appropriate.

2070 AIR VOLUME REGULATING AND CONTROL DAMPER IDENTIFICATION:

- Standards
    - Identify each regulating and control damper. Except where exposed in occupied areas. On ductwork dampers, clearly indicate commissioning set point.
- Identification colours
    - Use primary and secondary identification colours of associated system for painted or self colour discs.
- Discs
    - Securely attach metal or laminated plastic discs, minimum diameter 35mm, to each item.
- Legends
    - Engrave discs with permanent characters, minimum height 6mm.

2080 INSTRUMENT IDENTIFICATION:

- Standards
    - Identify each instrument by name and, where appropriate, by agreed reference characters.
- Plates
    - Use rectangular metal or laminated plastic, securely fixed to each instrument.
- Legends
    - Engrave plates with an approved text.

2090 DANGER AND WARNING NOTICES:

- Hazardous Systems
    - Colour code and label hazardous systems and equipment to requirements of Health and Safety Executive Guidance Notes.

2100# SYSTEM IDENTIFICATION INSTALLATION CHARTS:

- System Schematics
    - Supply and fix a referenced schematic diagram (or diagrams) of all systems as installed, including equipment and ancillary schedules. Show scheduled information on diagram.
    - Identify all items by appropriate reference characters.
- Control Schematics
    - Supply and fix a referenced schematic diagram (or diagrams) of all control systems as installed, including equipment and ancillary schedules. Show scheduled information on diagram.
    - Identify all items by appropriate reference characters.
- Location
    - Fix in each boiler house, calorifier room, plant room or equipment room.

SECTION Y60A - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. This Section includes boxes and raceways including conduits, wireways, and related installations and accessories necessary to support and protect cables, feeders, sub-feeders, branch circuit wiring and wiring of low current systems, communications and signal cables.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Regulations and Standards: Conduits, wireways, cable trays and fittings shall be designed, constructed and installed to give safe installation and reliable mechanical protection for wires and cables in accordance with the Regulations. Standards of products shall be as specified.

120.000 SYSTEM DESCRIPTION

120.010 RIGID HEAVY GAUGE STEEL CONDUIT

A. Material: Heavy gauge drawn and welded steel, threaded at both ends, to BS 4568-1 , with class 4 protection to BS 4568-1, zinc coated inside and outside by hot-dip process or sherardizing.

B. Fittings Generally: Threaded type, galvanized or cadmium plated malleable cast iron for conduits to BS standards and galvanized steel or die cast for conduits. Fittings used in corrosive atmospheres shall be specially treated.

C. Locknuts for securing conduit to metal enclosure shall be heavy hexagonal or castellated pattern, for fastening.

D. Bushings for terminating conduits shall be smooth rounded brass rings.

E. Miscellaneous fittings including reducers, chase nipples, three piece unions, split couplings and plugs shall be standard fittings designed and manufactured for the particular application.

120.020 RIGID INTERMEDIATE METAL CONDUIT

A. Intermediate Metal Conduit (IMC): rigid high grade mild strip welded steel, hot dip galvanized over the entire length including factory made treads after cutting with organic corrosion resistant polymer inside coating.

B. IMC Fittings Generally: threaded fittings and connectors and terminations with rigid coupling, concrete tight where required, and with red lead coated threads where site cut. Factory made bands shall be provided where site bending is not possible.

C. Corrosion Resistance: conduits used in corrosive atmospheres shall be copper silicon alloy or PVC coated IMC conduits and highly resistant to corrosion.

120.030 ELECTRICAL METAL TUBING

A. Electrical Metallic Tubing (EMT): welded steel, non-threaded type, galvanized externally and protected internally with corrosion resistant enamel.

B. EMT Fittings Generally: thread-less pressure type, galvanized or cadmium plated malleable cast iron. Fittings used in corrosive atmospheres shall be specially treated. Factory made bends shall be provided where site bending is not possible.

C. Corrosion Resistance: conduits used in corrosive atmospheres shall be made of aluminum or PVC coated EMT conduits and highly resistant to corrosion.

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120.040 FLEXIBLE STEEL CONDUIT

A. Material: Steel, cold rolled and annealed, non-threaded type, formed from continuous length of helically wound and interlocked strip steel, with fused zinc coating on inside and outside, and to IEC 61386.

B. Liquid-tight flexible conduit shall be used in indoor wet areas and shall have PVC jacket extruded over core.

C. Flexible steel conduits used outdoors shall be liquid tight, stainless steel grade 316, to UL360.

D. Fittings Generally: Threadless, hinged clamp type, galvanized or cadmium plated malleable cast iron. Fittings used in corrosive atmospheres shall be specially treated.

E. Straight Connectors: One piece body, female end, having hinged clamp and deep slotted machine screws for securing to conduit, male end having thread and locknut.

F. Angle connectors of 45 or 90 degree and terminal connectors shall be as specified for straight connectors, except that body shall be two-piece with removable upper section.

120.050 RIGID PVC-U CONDUIT

A. Material: Rigid unplasticized polyvinyl chloride (PVC-U) with high temperature resistance, flame retardant, non-hygroscopic and non-porous, to BS 4607, IEC 61386-1 and IEC 61386-21 or DIN 49016, heavy grade, classification code 4421, compression force 1250 N for conduits embedded in concrete and very heavy grade, classification code 5521, compression force 4000N for conduit exposed and / or concealed above false ceiling, IEC 61386-21, DIN 49016-1 or other equal and approved standards conforming to IEC 60423.

B. Fittings Generally: Unbreakable, non-inflammable, self extinguishing, heavy moulded plastic. Expansion couplings shall be telescoping double tube type, with at least two inner water-tight neoprene rings.

C. Assembly: Conduits, boxes and accessories shall be assembled by cementing, using manufacturer's recommended products and appropriate connectors or spouts. Where no spouts are available use smooth bore male PVC bushes and sockets.

120.060 FLEXIBLE PVC-U CONDUIT

A. Material: flexible unplasticized polyvinyl chloride (PVC-U), flame retardant, heat resistant, non-hygroscopic, high resistance to impact, ribbed on circumference for flexibility to IEC 61386-1, classification code 3321, compression force 750 N or other equal and approved standards.

B. Fittings Generally: unbreakable, non-inflammable, self extinguishing, heavy moulded plastic. Expansion couplings shall be telescoping double tube type, with at least two inner water-tight neoprene rings.

120.070 STEEL CONDUIT ACCESSORIES

A. Sleeves Through Outside Walls / Water Tanks: Cast iron, with end and intermediate integral flanges, and internal diameter larger than diameter of through-conduit. Length shall correspond to wall thickness. Space between sleeve and conduit shall be packed with backer rod/oakum to within 50 mm of both faces of wall, remainder of sleeve packed with plastic compound or lead, held in place by heavy escutcheon plates bolted at both ends to flanged ends of sleeve. Alternatively, sleeves shall be O.Z/Gedney, Type WSK or other equal and approved, with cable or conduit bolted pressure sealing components.

B. Sleeves Through Indoor Walls / Slabs: Similar to above but with cast iron or rigid heavy gauge galvanized steel and plain ends.

C. Supports and Hangers: Galvanized malleable cast iron straps or structural steel sections with hot dip galvanized bolts and nuts.

D. Expansion Joint for Embedded Steel Conduits - Type A: Watertight, flexible conduit with end fittings to receive fixed conduits. Length shall allow movement within range of joint and shall not be less than 20 times diameter of conduit. Conduit shall be covered with thick rubber tubing with 5

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mm minimum gap all around tube. Bonding jumper with earth clamp shall electrically connect both sides of joint. Fitting shall be O.Z/Gedney, Type DX or other equal and approved.

E. Expansion Joint for Exposed Steel Conduits - Type B: Sleeve with fittings to permit telescoping of one conduit into sleeve. Movable conduit shall be fitted with watertight bushing. Joint shall be weatherproof, of galvanized malleable iron or steel. Bonding jumper with earth clamp shall electrically connect both sides of joint. Expansion fitting shall be O.Z/Gedney, Type DXX or other equal and approved.

F. Expansion Joint for Exposed Steel Conduits - Type C: PVC sheathed flexible steel conduit terminating in pull boxes and securely fixed on each side of structural expansion joint. Bonding jumper shall electrically connect both sides of joint.

G. Tags: 50 mm diameter steel with indented lettering, rust inhibiting treatment and baked enamel finish.

120.080 WIRING AND CABLE TRUNKING

A. Components shall include wire way base, clip-on covers, couplings, end plates, wall flanges, panel to trunking rubber grommets, elbows, tees, adaptor plates and necessary hangers, supports and accessories.

B. Steel Trunking: To BS EN 50085-1 and BS EN 50085-2-1, galvanized sheet steel, minimum 1.5 mm thick, protected internally and externally with corrosion resistant finish such as zinc or cadmium with top coat of enamel. Return edge shall be provided for body. Cover fixing with simple arrangement. Stamped marking on lid and body by manufacturer. The galvanized sheet steel shall comply with BS EN 10143.

C. PVC Trunking: to BS 4678 part 4 high impact, heavy duty, self-extinguishing, rigid PVC with grooved double locking action of the clip-on cover. Design shall be approved by Engineer before ordering materials. Trunking shall be capable of receiving functional slot-in hangers and demountable separators to segregate wiring systems as needed.

D. Sizes: As required to accommodate number of conductors permitted by the Regulations and/or as shown on the Drawings. Sizing shall ensure 25 percent spare capacity.

120.090 WEATHERPROOF WIRING AND CABLE TRUNKING

A. Type: hot-dip galvanized sheet steel trunking of 1.5 mm thickness (minimum) with 1 mm thick cover to BS EN 50085-1 and BS EN 50085-2 for trunking and ISO 1461 for galvanizing and rated IP 54 to IEC 60529.

B. Construction: Trunking shall have outwardly turned flanges to receive cover, and internal sleeve coupling between sections, permitting cutting of trunking on site.

C. Gaskets: Neoprene bonded cork gaskets shall be fitted throughout, between any two attached surfaces.

D. Screws: Removable flanged covers shall be secured with galvanized steel holding screws.

120.100 SKIRTING TRUNKING

A. Type: Comprising wireway base, snap-on cover, couplings, end plates, wall flanges, elbows, tees, adapters, if required, and necessary clamps, hangers, supports and accessories. Wires and cables shall laid from front and held in place by clamps.

B. Steel Skirting Trunking: Sheet steel, 1.5 mm minimum thickness, protected internally and externally with corrosion resistant finish such as zinc or cadmium with top coat of enamel.

C. Aluminium Skirting Trunking: The raceway and all system components must be UL Listed in full compliance with their standard for surface metal raceways and fittings (UL-5). All extrusions shall be 6063-T5 aluminum alloy, with nominal wall thickness of 1.99mm throughout. The surface finish shall be satin, anodized #204 Type clear, Class R1 Mil-Spec with minimum anodized finish of 10mm.

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D. UPVC Skirting Trunking: High impact resistant, flame retardant UPVC (unplasticized polyvinyl chloride) to BS 476-6, BS 476-12 and BS 4678-4. Trunking shall be certified by approved Fire Laboratories.

E. Type: The raceway shall be a two-piece design with a base and snap-on cover. The base shall be furnished in 3m lengths and the cover sections shall be furnished in 1.5m lengths. The overall dimensions of assembled raceway shall be as shown on Drawings.

F. Trunking shall be partitioned continuously into compartments for separate circuits through extruded dividers separating the raceway into compartments.

G. The cover shall fit onto all compartments to allow access to only one compartment at a time.

H. The compartments and their separate covers must be available to handle both power and communications wiring.

I. Fittings: A full complement of fittings for the raceway shall be available. The available fittings should include, but not be limited to the following: flat, internal and external elbows, tee and cross fittings, wire clips, couplings for joining sections of raceway, grounding adapters as an NEC approved secondary grounding method, and transition connectors to conduits.

J. Device Covers: Device cover plates for mounting the following commercially available devices must be available: single devices, 40mm dia. socket, other rectangular faced devices and modular voice and data jacks.

K. Devices and Accessories: The raceway manufacturer will provide a complete line of connectivity outlets and modular inserts for socket outlets, Unshielded Twisted Pair, Shielded Twisted Pair, Fiber Optic, Coaxial and other cabling types with faceplates and bezels to facilitate mounting.

L. Dimensions: as shown on the Drawings and as required to accommodate specified wiring devices

120.110 PREWIRED PLUG-IN LIGHTING TRUNKING (HEAVY DUTY)

A. Type: overhead supported and prewired, supplied complete with 13 A, 3-pin special non-standard socket outlet for each luminaire, at spacing required and shown on the Drawings. Lengths of sections shall be determined by centers at which support brackets shall be mounted. Expansion shall be taken up by expansion fittings, and spacing of sections where applicable, and as recommended by the manufacturer.

B. Construction: 1.5 mm (16 b.g.) thick rigid mild steel sheet, with flanged cross-section to withstand loads up to 180 lbs (vertical/horizontal) with negligible deflection when supported at 4.0 m, and finished in stove enameled grey. Socket outlets shall be earth bonded. Purpose made support brackets shall be provided at regular spacing. Connecting set between sections (lengths) shall provide a stiffening joint and access into trunking through top plate. Flexible shall be provided between trunking sections to enable trunking to be turned in the horizontal plane for negotiating bends or curves.

C. Wiring and Plugs: each trunking length shall be wired with five single-core, 4 mm^2 PVC cables for alternate 3-phase, neutral and earth distribution, extended at least 150 mm beyond each end for easy field wiring between sections, and supplied with one 30 A connector block per length. Plugs shall be fused. End cable adapter on header shall be provided at each connection to a branch circuit.

D. Lighting Fitting Suspension: underside of trunking shall be formed in a continuous edge from which lighting fittings shall be suspended at two points, each by bolted hooks with locking screws to prevent accidental unhooking of fixture.

120.120 PLUG-IN OVERHEAD LIGHTING TRUNKING (LIGHT DUTY)

A. Regulations: Trunking shall conform to the National Electrical Code for overhead distribution of lighting circuits and low current circuits.

B. Components comprise wireway base, snap-on covers, couplings, end plates, wall flanges, panel to wireway rubber grommet, elbows, tees, adaptor plates and necessary hangers and supports.

C. Construction: 1 mm (0.04 inch) thick, galvanized steel, gray enameled (ANSI-61 gray). Sizes shall be selected to comply with the NEC and provide at least 25% space for future wiring.

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D. Laterals shall be supplied with 13 A, 230 V grounding socket outlets spaced to correspond with equipment layout and wired to correspond with control requirements shown on the Drawings.

120.130 OUTLET BOXES, GENERAL

A. Wiring devices back boxes and conduits pull boxes shall comply with BS 4662 / IEC 60670. Conduit circular pull boxes shall comply with BS 4607 / IEC 61386. Conduit junction boxes shall comply with IEC 60670-22. Floor boxes shall comply with IEC 60670-23.

B. Surface or recessed boxes shall be suitable for type of related conduit or cable system. Shapes and sizes of boxes shall be of compatible standards as switches and socket outlets specified under Division V Section "Wiring Devices", and lighting fixtures selected and of various types and mounting methods required.

C. Unused openings in outlet boxes shall be closed with molded caps or knock-out closers manufactured for the purpose.

D. Floor outlets and plates shall be water-tight and impact resistant.

120.130 METALIC OUTLET BOXES

E. Recessed and Concealed Boxes: Galvanized pressed steel, with knock-outs for easy field installation. Special boxes shall be punched as required on Site.

F. Exposed Surface Mounted Boxes: Galvanized cast iron with threaded hubs. As an alternative, UL listed boxes may be provided.

G. Outdoor Surface or Recessed Boxes: Galvanized cast iron with threaded hubs and PVC gaskets to ensure water tightness and with stainless steel or non-ferrous, corrosion resistant screws. As an alternative, UL listed boxes may be provided.

H. Floor Boxes - Type A: Watertight, cast iron or cast metal alloy with corrosion resistant finish, adjustable mounting, standard duty, round or square, factory drilled and tapped for required conduit sizes, and with brass cover and flange with brushed finish free from markings other than required for mounting screws.

I. Floor Boxes - Type B: non-standard size, flush floor mounted, cast metal alloy, with watertight neoprene gasket and hinged cover for each service. Box to be ready with factory drilled and tapped conduit entries and adjustable mounting fittings. Metal barriers shall separate services for power and low current.

J. Flame-Proof Boxes: Malleable iron or cast iron, with gas threaded hubs, special covers with silicon rubber gaskets, gas tight, and water-tight. Boxes shall comply with the Regulations for explosive areas.

K. Allow enough space for floor boxes lids to allow for the required finishing similar to the adjacent areas and in coordination with the ID/Engineer and Drawings.

120.140 MOLDED PLASTIC OUTLET BOXES

A. Type: Boxes and covers used with PVC conduit systems shall be heavy gauge pressure molded plastic, minimum 2 mm thick, self extinguishing, with softening point not less than 85 deg. C. Boxes shall have provision for securely terminating conduits and shall be manufacturer's standard for required application.

B. Fittings: Boxes shall have brass inset threads to receive cover screws and for mounting devices or accessories, push-fit brass earth terminals, and steel insert clips to provide additional support for pendants or for heat conduction. Neoprene gaskets shall be provided for weatherproof installations.

C. Molded plastic outlet boxes shall not be used outdoors.

120.150 FLUSH OUTLET BOXES

A. Factory designed, with accessories necessary to accommodate specific outlets shown on the Drawings or cable outlets as required for signal or control services, with cord-grip nipples. Finishes shall follow the corresponding application area.

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120.160 TERMINAL COLORING AND LABELING

A. Phase identification shall be marked in an approved manner on cable boxes, tail ends and single core cables and at all connecting points. Cable boxes shall be marked with stamped brass labels indicating the purpose of the supply where such supply is not obvious.

120.170 TERMINAL BOXES

A. The outer case of terminal boxes shall be constructed of steel sheet or weather resistant reinforced plastic subject to Engineer's approval and fitted with one or more hinged covers provided with fasteners and padlocking facilities. The boxes shall be of IP56 for outdoor installations and IP51 for indoor installations.

B. The case shall be adequately ventilated also dust and vermin proof. Removable gland plates shall be provided at the top and bottom. They shall be supplied complete with suitable insulating material capable of withstanding the climatic conditions and test voltages specified herein where the glands are required to be insulated from the terminal boxes. If the width of the box necessitates the provision of 2 hinged front covers they shall close on to a center post which shall be removable to facilitate cable termination. The depth of the outer case shall be not less than 200 mm unless otherwise approved by the Engineer.

C. The outer cases shall be treated before painting to prevent corrosion and shall be finished in glossy enamel to an approved color externally and white internally. Where terminal boxes are required for installation outdoors or in damp situations, they shall be of water tight construction and galvanized.

D. Terminal boards shall comprise banks of rail mounted, screw clamp, spring loaded insertion, solder lug or stud type terminals as required to suit the design and duty of the cables to be terminated, arranged in pairs horizontally and grouped in vertical formation to provide a rigid assembly. Each pair of terminals shall be connected together at the base with a fixed or plug type link as specified. Insulating high temperature material of self-extinguishing or resistant to flame propagation and substantially non-hygroscopic type shall be molded around the base of the screws or studs, links connecting pairs of screws or studs or plug sockets to prevent exposure of live metal at the back of the terminal boards and to secure the terminals against rotation and displacement.

E. Stud type terminal boards shall have screws or studs of 5 mm dia. for phosphor bronze or stainless steel, and 6 mm dia. for high tensile brass, unless otherwise approved. They shall be complete with the appropriate clamps, springs, nuts, locknuts and washers.

F. Terminal boards shall be complete with approved means for securing the wires, identification ferrules, insulating barriers between pairs of terminals and removable transparent non-inflammable terminal covers fitted with marker strips for identifying the terminals. All nuts, washers, links and other components provided for securing the wires shall be electro-tinned. Springs shall be aged and shall withstand corrosion.

G. The clearance between adjacent terminal boards and from the sides of the case shall not be less than 100 mm. The minimum clearance between terminal boards and the top and bottom of the case shall be 150 mm.

H. All terminal boxes and boards shall meet the associated cable site tests.

120.180 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS: INNERDUCT

A. Innerduct for Outdoor use (OSP):

1. Suitable for use typically within a duct bank system for the support of telecommunications fiber optic cables.
2. Continuously extruded corrugated flexible non-metallic pipe smooth from inside, fabricated from HDPE (High Density Polyethylene), or equivalent.
3. Measured Pull tape: pre-lubricated, woven polyester, low friction, and high abrasion resistant yarn with a minimum average tensile strength of 1250 lbs. for 50mm and smaller conduits and 1800 lbs. for conduits larger than 50mm.
4. Inner diameter: 2-inch, 3-inch and 4-inch or as shown on Drawings.

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5. Detectable innerduct: manufactured with a solid copper, polyvinyl color coated conductor 1.0 mm diameter minimum for tracing and rated for a minimum of 6 amps and 600 volts. Conductor shall be placed in the sidewall edge fold of the innerduct sleeve.
6. Provide any accessory products related to the innerduct assembly system required to provide a complete and functional system, as intended by the Engineer and manufacturer, including, but not limited to: Innerduct fittings conduit plugs and penetration sealing materials.

B. Innerduct for indoor use (ISP):

1. Suitable for use typically within a riser system or backbone conduit, and within plenum spaces, such as above ceiling or within an access floor, for the support of telecommunications fiber optic cables
2. Comply with UL 2024 for flame propagation and smoke density values for use in air handling applications.
3. Continuously extruded corrugated flexible non-metallic pipe smooth from inside.
4. Measured Pull tape: pre-lubricated, woven polyester, low friction, and high abrasion resistant yarn with a minimum average tensile strength of 1250 lbs. for 50mm and smaller conduits and 1800 lbs. for conduits larger than 50mm.
5. Inner diameter: 2-inch, 3-inch and 4-inch or as shown on Drawings.
6. Provide any accessory products related to the innerduct assembly system required to provide a complete and functional system, as intended by the Engineer and manufacturer, including, but not limited to: Innerduct fittings conduit plugs and penetration sealing materials.

PART 1 REFERENCES

100.000 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and Division A Specification Sections, apply to this Section.

110.000 RELATED SECTIONS

A. Division P Section " Fire Stopping Systems "

B. Division V Section "Basic Electrical Materials and Methods" for raceways and box supports.

C. Division V Section "Wiring Devices" for devices installed in boxes and for floor-box service fittings.

PART 2 PRODUCTS AND WORKMANSHIP

200.000 MATERIALS

200.010 MANUFACTURERS

A. Approved Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

1. Steel Conduits:

a) Thomas & Betts
b) Cable Tek Inc.
c) Swift/Legrand
d) Allied Tube
e) Barton Eng'g
f) Walsall G.E.C.
g) Panasonic
h) International Metal Hose
i) Wheatland Tube

2. Flexible Steel Conduits:

a) Halex (USA)

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b) Electri-Flex Co.
c) AFC

3. PVC Conduits and Fittings:

a) Dietzel-Univolt
b) EGA Tubes/M.K./Honeywell
c) Marshall Tufflex
d) Comat
e) Interplast
f) Clipsal

4. Accessories and Fittings:

a) Hubbell
b) O.Z./Gedney
c) Steel City

Same manufacturer as conduit or other approved, and to the satisfaction of Engineer.

5. Prewired Plug-In Lighting Trunking (Heavy Duty)

a) Legrand Salamndre , of pre-designed sections (lengths) to meet modular construction on site.

6. Plug-In Overhead Lighting Trunking (Light Duty)

a) Wiremold/Legrand

7. Metallic Outlet Boxes

a) Hubbell
b) O.Z./Gedney
c) Steel City

8. Moulded Plastic Outlet Boxes

a) Egatube/M.K./Honeywell
b) M.K./Honeywell

200.020 PRODUCTS

A. Products: Subject to compliance with requirements, provide one of the products indicated for each designation as shown on plans.

210.000 QUALITY MANAGEMENT

210.010 QUALITY ASSURANCE

A. All products shall carry permanent marking by manufacturer.

B. All materials shall be stored in covered areas and protected from dust and dampness.

210.020 COORDINATION

A. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

220.000 SUBMITTALS

A. Product Data: Submit data for approval including, but not limited to, manufacturers' catalogues with specifications of raceways including conduits, trunking, boxes, etc. and related accessories

B. Point-wise compliance statement to the specifications, duly signed by the manufacturer/ manufacture’s authorized representative and the contractor.

C. Shop and Construction Drawings: Submit drawings for approval including, but not limited to, the following:

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1. Exact routing of conduits, trunking etc. with indication of boxes, accessories and expansion joints, size and type of conduits and boxes.
2. Typical assembly details of installation of trunking, trays etc.
3. Construction details of pull boxes.
4. Typical installation details including connection of conduits to metal enclosure, connection of flexible conduits, vapour-tight installations in cold rooms, weatherproof installations outdoors etc. and earthing connections.
5. For prewired installations, submit drawings for approval showing the complete layout of all products that make up the complete system for each floor prior to the installation of raceway lengths, device type (power and data), locations and circuits identified.

D. Samples of each type of raceway, box, and accessory.

E. As-Built (Record) Drawings: At Project close-out, submit Record Drawings of installed electrical raceways and boxes, in accordance with requirements of the Specification, Division 01.

230.000 EXECUTION

230.010 EXAMINATION

A. Examine surfaces to receive raceways and boxes for compliance with installation tolerances and other conditions affecting performance of raceway installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

230.020 CONDUIT, WIREWAYS, AND BOXES, GENERAL

A. Use: Light and power circuits, communications, signal and low current systems wiring shall be drawn inside conduits or wireways up to the various electric power consuming equipment as shown on the Drawings. Circuits are allowed to run in cable trays or cable baskets where there is sufficient space above ceiling as required in Division Y Section "Cable Trays for Electrical Systems".

B. Separate conduits and wireway installations shall be used for medium voltage cables, low voltage feeders and sub-feeders, normal light and power circuits, emergency light and power circuits and communication, signal and other low current systems wiring. Cables of different voltages shall not be mixed within the same conduit or wireway as per the regulations.

C. Boxes: Pull, and splice boxes of ample capacity shall be provided as indicated or required. Boxes shall remain permanently accessible.

D. Exposed Outlet Boxes: Securely fasten to wall with machine screws to permanent inserts or lead anchors.

E. Recessed Outlet Boxes: Make neat openings, to the satisfaction of Engineer, allowing for thickness of finishings, and use extension rings if required. Repair damaged finishings to original condition before installation of fittings or plates.

F. Boxes Mounting Heights and Location: As specified under Section "Wiring Devices", and as shown on drawings.

G. Boxes: Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

H. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

I. Tools and accessories for forming and installing conduit and wireway systems shall be purpose made for the particular application and used in accordance with manufacturers' instructions.

J. Fixing: Conduits and wireway installations shall be concealed as much as possible.

K. Sizes of conduits and wireways, not shown on the Drawings, shall be selected in accordance with the Regulations and in relation to the number and size of conductors and the space factor as recommended by the regulations. Minimum outer diameter of conduit for all applications shall be 25 mm, unless otherwise shown on the Drawings.

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L. Spare capacity shall not be less than 25 percent for all raceways.

M. Mechanical Continuity: Conduits and wireways shall be effectively joined together and connected to electrical boxes, fittings and cabinets to provide firm mechanical assembly. Earthing jumpers shall be installed on steel conduits where required to ensure effective electrical continuity irrespective of whether a separate protective earth conductor is required or not.

N. Metal conduits and enclosures shall be mechanically fastened, and to be connected to electrical boxes, fittings and cabinets to form low electrical resistance continuity and firm mechanical assembly.

O. Dissimilar Metals: Use of dissimilar metals shall be avoided throughout the system to eliminate possibility of electrolysis. Where dissimilar metals are in contact, treat surfaces with corrosion inhibiting compound before assembling.

P. Miscellaneous fittings such as reducers, chase nipples, 3 – piece unions, split couplings and plugs that have been specifically designed and manufactured for their particular application shall be installed as necessary.

Q. Conduits shall be tested with a mandrel. Conduits that reject a mandrel shall be replaced. Restore conduit and surrounding surfaces to original condition.

R. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.

S. No more than one wire is permitted to be terminated at one terminal.

T. Labeling of raceways and boxes; size of letters and color of labels, marking and references shall be as per the relevant standard regulations. Expansion coupling and fittings are to be installed near expansion joints.

230.030 CONDUITS AND WIREWAYS APPLICATIONS AND INSTALLATION, GENERAL

A. Conduits and wireways installations shall be as described below, unless otherwise shown on the drawings or described in the particular section of the Specification.

B. Rigid heavy gauge steel conduit or intermediate metal conduit (IMC) shall be used for medium voltage cables & low voltage feeders installation where installed in non-accessible false ceiling areas, indoor damp / wet areas (e.g. kitchen, laundry, boiler rooms, etc.), outdoor installations and explosion-proof installations in hazardous areas.

C. Electrical Metallic Tubing (EMT) shall be used for exposed installations over false ceilings when the false ceiling is used as a return plenum.

D. Electrical Metallic Tubing (EMT) shall be used for exposed and above false ceiling wiring installations used in conjunction with exit and escape route lighting/central battery circuits, fire alarm & security installations.

E. Electrical Metallic Tubing (EMT) shall be used for all installations in elevator machine rooms and shafts, electrical equipment rooms, mechanical rooms, parking floors, kitchen, laundry and solid waste rooms.

F. Electrical Metallic Tubing (EMT) shall be used for concealed installations in dry / gypsum board walls.

G. Electrical Metallic Tubing (EMT) shall be used for exposed installations in car park areas.

H. Conduit termination in sheet metal enclosures shall be fastened by lockouts, and terminate with bushing. Install locknuts inside and outside enclosure.

I. Rigid PVC-U conduit shall be used for lighting and power circuits, low current, communication and signal system wiring, where embedded in concrete, masonry, underfloor, except where otherwise shown on the Drawings or described in the particular section of the specification.

J. Rigid PVC-U conduit shall be used above false ceilings for lighting and power circuits, low current, communication and signal system wiring, when the false ceiling is not used as return plenum – and

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in furred walls. Use flexible PVC-U conduits from outlet boxes to fixtures in conjunction with the use of PVC-U conduits.

K. Flexible conduit of same material as corresponding conduit system shall be used for connection to motors, vibrating and non-rigidly fixed equipment and to fixtures installed in false ceilings.

L. Equipment requiring fixed connection or heavy electric power shall be supplied by means of flexible cord housed in metallic conduit from suitable disconnect switch, mounted adjacent to the equipment on the wall.

M. Flexible steel conduit shall be used in movable partitions and from outlet boxes to fixture over false ceilings when used as a return plenum. Conduits shall be liquid tight in damp areas.

N. Liquid-tight flexible steel galvanized conduit shall be used in one or more of the following conditions:

1. Exterior location.
2. Moist or humid atmospheres where condensate can be expected to accumulate.
3. Corrosive atmosphere.
4. Subjected to water spray or dripping oil, water or grease.

O. Exposure to Damage: Conduit considered to be subject to undue risk of damage by shock or corrosion shall be brought to the attention of the Engineer. Copper silicone alloy tubes may be used in corrosive atmospheres.

P. Crossing: Conduits shall not cross pipe shafts, vents or openings.

Q. Clearances: Install conduits at least, 150 mm clear of and preferably above pipes of other non-electrical services. (Hot water pipes, etc.). Wherever possible, install horizontal conduit and wireways runs above water and steam piping.

R. Sleeves: Obtain approval for positioning sleeves where conduits pass through reinforced concrete. Additional opening may be allowed in finished slabs, but shall be drilled. Fix sleeves rigidly to maintain position and alignment during construction work.

S. Waterproof Construction: Conduits shall not cross waterproof construction unless permitted by Engineer. Specially designed and approved fittings shall be used.

T. Expansion Fittings: Provide in each conduit and wireways run every 30 meters, or wherever structural expansion joints are crossed.

U. Make good all holes for conduits passing through walls, floors and ceilings with cement or similar fire-resisting material to full thickness.

V. Bends: Conduit runs between outlet and outlet, fitting and fitting or outlet and fitting shall not contain more than the equivalent of 2 quarter bends (180 degree total).

W. Bending shall be made without damaging conduit or tubing and without reducing internal diameter. Methods of field bending shall be approved.

X. Cut ends shall be reamed to remove burrs and sharp edges.

Y. Conduits entering cold stores shall be made vapour tight, so that vapour from outside cannot enter conduit.

Z. Draining: Arrange conduits so that condensed moisture can drain to screwed plug at lowest point.

AA. Before wiring, conduits shall be swabbed through. Do not draw cables into any section of system until conduit and draw boxes are fixed in position, and the raceway installation is completed.

BB. Capping: Conduits shall be properly capped until wiring conductors are drawn in.

CC. Conduit and fittings installed outdoors shall be watertight and highly resistant to corrosion. Use appropriate fittings, threaded and hubbed boxes, gaskets with screw on covers and the like.

DD. Terminations: Do not terminate or fasten rigid conduits to motor frame or base.

EE. Length and radius of flexible conduit used for motors and vibrating equipment shall permit bending of feeder cables without damage to conductor or insulation.

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FF. Flexible conduit for slide rail mounted motor shall have sufficient slack to allow for movement of motor over entire slide rail length.

GG. Pulling Wire: Install 3 mm galvanized stranded steel wire or equivalent strength cord with wooden blocks fastened at ends, in empty service conduits (power, low current and signal).

HH. Standard elbows shall be used for conduit sizes over 40 mm. For smaller sizes, field bends may be used provided no damage occurs to conduit.

II. Tags: Fit to conduits entering or leaving floors, walls or ceilings for identification of conduit and circuits. Tags are also to be placed at suitable intervals throughout the system.

JJ. Non – ferrous conduit shall be installed for circuits operating above 60 Hz.

230.040 STEEL CONDUITS

A. Termination: Conduit entering sheet metal enclosure or outlet boxes, when not terminated in a threaded hub, shall be securely held in place by two lock-nuts, placed inside and outside enclosure, and terminated with an insulating bushing.

B. Running Threads: Do not use running threads at joints and terminations, but use 3-piece unions or split couplings.

C. Additional threaded cuts on galvanized steel conduits shall be painted with zinc based coating resistant to corrosion.

D. Damage to protective coating of conduits shall be repaired to original degree of protection.

E. Outdoor Mounted Steel Conduit: Apply anti-corrosion coating of zinc-chromate based paint and two weather resistant finish coats of enamel, of approved colour, or other equal and approved coating.

F. Galvanized conduit run in screed shall be painted with heavy coat of emulsified bitumen.

G. Galvanized steel conduits buried in ground or placed in wet or damp locations shall be coated with two heavy coats of hot bitumen. Conduits shall be covered by at least 600 mm of earth if buried in planting soil and by 300 mm if under walkway.

H. Plugs: Use hardwood or threaded iron plugs for blanking ends of steel conduit not used.

230.050 PVC CONDUITS

A. Coupling of conduit and/or termination into spouted fittings shall be made watertight and permanent using special cement.

B. Termination: Connect conduits terminating in switchgear, fuseboards, trunking, adaptable boxes or other non-spouted enclosures etc. with smooth bore male PVC bushes and sockets.

C. Ends of conduit and conduit fittings shall be cleaned and jointed using PVC cement recommended by manufacturer.

D. Semi-Permanent Adhesive: Use in joints requiring expansion couplers.

E. Bends: Conduits not exceeding 25 mm diameter may be cold bent using bending springs. Conduits over 25 mm shall be hot bent by an approved method.

230.060 EMBEDDED CONDUITS

A. Conduits In Concrete Slabs: Place conduits parallel or at right angles to main reinforcing steel, between bottom reinforcing and top reinforcing steel. Fasten conduits to reinforcing steel by positive wire, fasteners at the proper distance from the concrete face. Embedded conduit diameter shall not exceed 1/3 of slab thickness. Special cases shall be referred to Engineer.

B. Conduits In Partitions or Side Walls: Horizontal or cross runs shall be avoided.

C. Pull-boxes shall not be used except for concealed installations above false ceiling at accessible locations. If unavoidable, pull-boxes may be approved if located inconspicuously.

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D. Conduits in floor of beds on grade: Encase in concrete, minimum thickness 50 mm or to thickness allowed by architectural detail.

E. PVC conduits in reinforced concrete structures are generally to be installed after placing reinforcement and before concreting, if protected against damage, or shall be placed in grooves formed in the concrete, if approved.

230.070 EXPOSED CONDUITS

A. Conduits on walls shall be run neatly, horizontally or vertically.

B. Supports: Use approved clamps, hangers or clips fastened by machine screws to expansion sleeves in inserts or to lead anchors.

C. Spacing of clamps or clips for supporting steel conduits shall not be greater than:

	Conduit Size mm	Maximum Spacing of Supports metres
1.	20	3.00
2.	25	3.60
3.	32-38	4.25
4.	50-63	5.00
5.	75 and larger	6.00

D. Spacing of clamps or clips for supporting PVC conduits shall not be greater than:

	Conduit Size mm	Maximum Spacing of Supports metres
1.	20	0.60
2.	25-50	0.75
3.	63-75	0.90
4.	90-125	1.00
5.	150	1.25

E. Bends and Fittings: Firmly fasten conduit at each side of bends and within 900 mm of each outlet box, junction box, cabinet or fitting.

F. Outlets: Do not run more than the permissible numbers of conduits to any surface wall outlet.

G. Exposed conduit work shall be installed so as not to interfere with ceiling inserts, lights or ventilation ducts or outlets.

230.080 CABLE TRUNKING

A. Installation: Secure trunking of all sizes at intervals not exceeding 1200 mm. Joints shall not overhang a fixing by more than 500 mm.

B. Trunking passing through walls and ceilings shall have the cover fixed solidly for 25 mm either side of walls and for 150 mm either side of floors and ceilings.

C. Trunking passing through fire barrier walls shall be provided with approved fire stopping barrier inside the trunking.

D. Vertical sections of trunking over 900 mm long shall have staggered insulated tie-off studs to support weight of cables.

E. Cabling Provisions: Separation of power, low current and control circuits shall be by two channel trunking or by barriers inserted in trunking before installation of cables. Cable retaining straps shall be provided at not more than 600 mm centers. Openings in front of trunking shall facilitate drawing-in cables.

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F. Coupling: Trunking parts shall be mechanically and electrically coupled without causing abrasion to wiring.

G. Connection of trunking to conduits shall be through circular boxes.

H. Earthing: Do not use metal trunking as earth continuity conductor. Provide protective conductor in accordance with Division Y Section "Earthing and Bonding" of the Specification.

230.090 PATHWAYS FOR OPTICAL-FIBER AND COMMUNICATIONS CABLE

A. Install pathways, metallic and nonmetallic, rigid and flexible, as follows:

1. Comply with EN 50174-1 and EN 50174-2.
2. 20-mm (3/4-Inch) Trade Size and Smaller: Install pathways in maximum lengths of 15 m (50 feet).
3. 25-mm (1-Inch) Trade Size and Larger: Install pathways in maximum lengths of 23 m (75 feet).
4. Install with a maximum of two 90-degree bends or equivalent for each length of pathway. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.
5. The inside radius of a bend in conduit shall be at least 6 times the internal conduit diameter.
6. Bends in the conduit shall not contain any kinks or other discontinuities that may have a detrimental effect on the cable sheath during cable pulling operations.

230.100 LABELING

A. All metal conduits and metal trunking shall be labeled with type of service, using approved color and lettering labels, fixed at specified distances as specified in Division V Section “Basic Electrical Material and Methods”.

230.110 UNDERGROUND DUCTS

A. Lay and assemble ducts in accordance with Division V Section "Underground Ducts and Raceways for Electrical Systems".

230.120 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure coatings and finishes are without damage or deterioration at the time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

230.130 CLEANING

A. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION Y60A

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Y61A - MEDIUM-VOLTAGE CABLES

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. This Section includes cables and related splices, terminations, and accessories for medium-voltage electrical distribution systems above 1000V rating.

110.000 DESIGN PARAMETERS

110.010 PROJECT/SITE CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Employer or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Engineer at least 2 days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Engineer's written permission.

110.020 REFERENCE STANDARDS

A. Standards: Cables shall comply with IEC or other equally approved Standards, and shall bear the mark of identification of the Standards to which they are manufactured. Cables not having this identification will be rejected.

120.000 SYSTEM DESCRIPTION

120.010 MV CABLE

A. Three Core MV Cable, 8.7/15 (17.5) kV, XLPE insulated, for use on systems with 15 kV, shall comply with IEC 60502 & IEC 60332-3-24, and have the following characteristics:

1. Conductor: Copper or Aluminum as shown on the drawings, circular, stranded and compacted.
2. Conductor Screen: Extruded semi-conducting layer.
3. Insulation: Extruded cross-linked polyethylene (XLPE), nominal 4.5mm thick.
4. Insulation Screen Part: Non-metallic directly applied extruded semi-conducting material, readily strippable.
5. Metallic Part: Layer of copper tape applied with 30% overlap, copper wire or combination of both, with equivalent cross sectional area of 35 mm^2 as a minimum, DC resistance of the screen shall be measured on the complete cable and the resistance value corrected to 20 deg. C in accordance with IEC 60228 and shall not exceed the relevant value of BS 6622.
6. Filling and Bedding: Extruded PVC to form compact circular bedding.
7. Armor where required on the drawings: Single layer of round galvanized steel wire or double galvanized steel tape as shown on the drawings.
8. Outer Sheath: Extruded PVC (color red) type ST2 to IEC 60502, flame retardant to IEC 60332-3-24
9. Medium voltage cables shall be color coded using colored tape applied under the metallic shield or otherwise identified as required by the regulations and as follows:

    a) Phase colors shall be red, yellow, blue or use color coding in accordance with local regulations and standards.

10. If Low Smoke Zero Halogen (LS0H) cable is required on the drawings, bedding and outer sheath shall be made of LS0H material to IEC 61034 for low smoke emission, IEC 60754-1 for halogen acid gas content and IEC 60754-2 for degree of acidity of evolved gas.
11. Embossing: Electric cable, manufacturer name, number of cores and size, type (e.g. CU/XLPE/SWA/PVC), voltage rating (e.g. 8.7/15 (17.5) kV), manufacturer standards, special

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characteristics (e.g. FR to IEC 60332-3-24, LS0H to IEC 61034, IEC 60754-1 and 2 as specified or required on the drawings).

12. Short-circuit: 8 kA (minimum) for one second rating for 95 mm^2 Aluminum cables, 11 kA (minimum) for one second rating for 120 mm^2 Aluminum cables, 14 kA (minimum) for one second rating for 150 mm^2 Aluminum cables, 17 kA (minimum) for one second rating for 185 mm2 Aluminum cables, 22 kA (minimum) for one second for 240 mm^2 Aluminum cables, 28 kA (minimum) for one second rating for 300 mm^2 Aluminum cables, 13 kA (minimum) for one second rating for 95 mm^2 Copper cables, 17 kA (minimum) for one second rating for 120 mm^2 Copper cables, 21.4 kA (minimum) for one second rating for 150 mm^2 Copper cables, 26.4 kA (minimum) for one second rating for 185 mm^2 Copper cables, 34 kA (minimum) for one second rating for 240 mm^2 Copper cables and 42 kA (minimum) for one second for 300 mm2 Copper cables.

B. Single Core MV Cable 8.7/15 (17.5), XLPE - insulated, for use on systems with 15 kV, shall comply with IEC 60502 & IEC 60332-3-24, and have the following characteristics:

1. Conductor: Copper or Aluminum as shown on the drawings, circular, stranded and compacted.
2. Conductor Screen : Extruded semi-conducting layer.
3. Insulation: Extruded cross-linked polyethylene (XLPE), nominal 4.5 mm thick.
4. Copper Screen: Layer of copper wires with copper tape applied in opposite direction bedding, with equivalent cross sectional area of 35 mm2 as a minimum, DC resistance of the screen shall be measured on the complete cable and the resistance value corrected to 20 deg. C in accordance with IEC 60228 and shall not exceed the relevant value of BS 6622. Inner tape covering and separation sheath of extruded PVC.
5. Armored cable, where required or shown on the Drawings, shall have single layer of aluminum wire or two layers of aluminum tape between bedding and over-sheath.
6. Outer Sheath: Extruded PVC (color red) type ST2 to IEC 60502, flame retardant to IEC 60332-3-24.
7. If Low Smoke Zero Halogen (LS0H) cable is required on the drawings, bedding and outer sheath shall be made of LS0H material to IEC 61034 for low smoke emission, IEC 60754-1 for halogen acid gas content and IEC 60754-2 for degree of acidity of evolved gas.
8. Embossing: Electric cable, manufacturer name, number of cores and size, type, voltage rating (e.g. 8.7/15 (17.5) kV), manufacturer standards, special characteristics (e.g. FR to IEC 60332-3-24, LS0H to IEC 61034, IEC 60754-1 and 2 as specified or required on the drawings).
9. Short-circuit: 8 kA (minimum) for one second rating for 95 mm^2 Aluminum cables, 11 kA (minimum) for one second rating for 120 mm^2 Aluminum cables, 14 kA (minimum) for one second rating for 150 mm^2 Aluminum cables, 17 kA (minimum) for one second rating for 185 mm2 Aluminum cables, 22 kA (minimum) for one second for 240 mm^2 Aluminum cables, 28 kA (minimum) for one second rating for 300 mm^2 Aluminum cables, 37 kA (minimum) for one second rating for 400 mm^2 Aluminum cables 13 kA (minimum) for one second rating for 95 mm^2 Copper cables, 17 kA (minimum) for one second rating for 120 mm^2 Copper cables, 21.4 (minimum) for one second rating for 150 mm^2 Copper cables, 26.4 kA (minimum) for one second rating for 185 mm^2 Copper cables, 34 kA (minimum) for one second rating for 240 mm^2 Copper cables, 42 kA (minimum) for one second for 300 mm^2 Copper cables, 57 kA (minimum) for one second rating for 400 mm^2 Copper cables, 71 kA (minimum) for one second rating for 5000 mm^2 Copper cables and 90 kA (minimum) for one second rating for 630 mm^2 Copper cables.

C. Single or multi core cables installed in cable culvert / tunnels shall be anti-termite and anti-rodent type through providing the outer sheath with organic, non-toxic, anti-termite and anti-rodent agent forming 1.5% of sheath weight.

120.020 CABLE TERMINATION AND SPLICE CONNECTORS

A. Type: Cable termination and splice connectors shall comply with class A to IEC 61238-1 and tested in accordance with IEC 61442 and IEC 60502-4 or class I to IEEE 48 for termination, IEEE 404 for splices, IEC 60137 and BS EN 50181 or IEEE 386 for elbow termination connectors.

B. Termination and splicing kits shall be either heat shrinkable or cold shrinkable type.

C. Kits shall include stress control filler and tube, extruded leakage insulating mastic between cable and shield ground braid, seal and outer non tracking tubes. Non tracking skirts shall be provided for

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installation in outdoor or wet areas. Kits shall be suitable for cable size and include necessary termination lugs and sleeves.

D. Stress control and stress grading wherever necessary in the terminations shall be by means of semiconducting heat shrinkable tubing.

E. Connectors shall be compression, barrel crimped type.

F. Connectors for copper conductors shall be made of electrolytic copper.

G. Connectors for aluminum conductors shall be made of aluminum alloy of purity not less than 99.5%.

H. All termination and splice connectors specified above shall be tin plated with minimum thickness of 5 microns for copper material and 7 microns for aluminum material. Aluminum connectors shall incorporate neutral grease to avoid aluminum oxidation

I. Termination connectors for aluminum-copper termination shall consist of barrel made of aluminum alloy of purity not less than 99.5% and palm made of forged copper connected using a friction stir welding.

J. Splice connectors for aluminum-copper termination shall consist of two barrels, one is made of electrolytic copper and the other is made of aluminum alloy of purity not less than 99.5% connected using a friction stir welding.

K. Splice connectors shall have a central stop to divide the connector into two equal parts to facilitate the correct cable positioning.

L. Connectors shall be as recommended by manufacturer, to render joints equal to cable in characteristics, in terms of insulation, stress distribution and water-tightness. Materials and methods of jointing shall be approved before confirmation of order.

M. Elbow type terminator shall be used for connection to load break switch / ring main unit with covering boot/bushing as applicable.

N. Connector insulation: Connectors shall be insulated using proper material including insulated sleeves, boots, bushing… etc. as applicable.

O. Termination kits for VFD cables shall be approved for use with VFD cables and shall include necessary earthing clamps / straps for conductor and cable EMI shields and 6-legs break out boot to enclose all the 3-phase conductors and 3-earth conductors.

P. All components of lugs and connectors shall be clearly marked with the manufacturer's name, die number, cable / conductor size, number of crimps and position.

120.030 CABLE CLEATS

A. Cable cleats shall be classified, tested and certified according to IEC 61914.

B. Cleats shall be made of Aluminum, withstand temperature range -5° C - +60° C, classified as "Very heavy" (20 J impact energy at 400mm height as minimum) for their resistance to impact and shall withstand electromechanical forces for more than one short circuit. Cleat short circuit rating for both RMS and Peak values shall exceed the design short circuit level at project site.

C. Cleats shall be trefoil type for single core cables and round type for multi core cables, selected to suit the installed cable(s) outer diameter and shall be provided with low smoke zero halogen pad/liner for cable mounting and protection.

D. Cable cleat edges shall be free of sharp edges, burrs and cracks and shall not cause any damage to the cable sheath in the event of short circuit.

E. Cleats shall be suitable for support to racks, trays or ladders using single or double bolt fixation along with necessary fixation accessories.

F. All cleats shall be clearly marked with the manufacturer's name, product identification or type and cable outer diameter range.

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PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and Division 01 Specification Sections, apply to this Section.

210.000 RELATED SECTIONS

A. Related Sections include the following:

1. Division V Section "Basic Electrical Materials and Methods" for cable and termination supports.
2. Division V Section "Basic Electrical Materials and Methods" for cable markers.

PART 3 PRODUCTS AND WORKMANSHIP

300.000 MATERIALS

300.010 MANUFACTURERS

A. Approved Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

1. Medium Voltage Cables:

a) B.I.C.C.
b) Nexans
c) Prysmian
d) The Okonite Co.
e) Draka
f) Amer Cable
g) Bahra Cables

2. Cable Connectors:

a) Raychem
b) 3M
c) B.I.C.C.
d) Nexans
e) Prysmian
f) Klauke

3. Cable Cleats:

a) Cooper B-Line
b) Ellis

300.020 PRODUCTS

A. Products: Subject to compliance with requirements, provide one of the products indicated for each designation as shown on plans.

310.000 QUALITY MANAGEMENT

310.010 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced and certified cable splicer to install, splice, and terminate medium-voltage cable.

B. Current carrying capacities of conductors have been determined in accordance with the Regulations for specified type of insulation and expected conditions of installation. No change will be accepted in specified type of insulation unless warranted by special conditions and approved by the Engineer.

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Check various loads and current carrying capacities and report any discrepancies or insufficiency of sizes indicated to Engineer.

310.020 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle medium-voltage cables as per the Manufacturer’s instructions.

310.030 FACTORY ACCEPTANCE TESTS

A. Factory acceptance tests of medium voltage cables under this Contract are subject to be witnessed by the Engineer for locally manufactured cables. Witness test shall include complete routine and sample tests to IEC 60502-2 and additional DC resistance of the screen test on all cables to be witnessed. Impulse test shall be included in the witness unless manufacturer’s facility is not equipped for such a test. Test procedure and program shall be submitted for approval prior to test conduction. Allow for test expenses including business class transportation and hotel accommodation as necessary for two persons from the Engineer’s/ Employer’s side.

310.040 SPARE PARTS AND EXTRA MATERIAL

A. Furnish extra materials described below that match products installed in the project:

1. MV VFD Cables: adequate length for at least two drives.
2. Submarine Cables: adequate length for two motors.
3. Other special imported cables with very long delivery time.

320.000 SUBMITTALS

A. Technical Data: Submit data for approval including, but not limited to, the following:

1. Constructional details, standards to which cables comply, current carrying capacities, de-rating factors for grouping and temperature.
2. Manufacturer's catalogue cuts.
3. Dimensional and electrical characteristics.
4. Manufacturer's drawings showing the outline of the lugs and sleeve connectors together with all pertinent dimensions. Any variation in these dimensions due to manufacturing tolerances shall be indicated.

B. Samples of each cable and, if requested by the Engineer, other accessories.

C. Shop and Construction Drawings: Submit drawings for approval including, but not limited to, the following:

1. Exact routing layouts, showing coordination between various trades.
2. Details of supports and fixings for trays and cables.
3. Details of connections to transformers, switchgear, etc.
4. Details of terminations, splices and tapings where permitted, glands and bushings at enclosures.

D. Certificate of Origin: For each lot of cable supplied, provide a certificate of origin issued by manufacturer stating origin, date of manufacture, composition, Standards to which it complies and test certificates. All test certificates shall comply with the test requirements of the relevant standard to which the cable is manufactured.

E. Cable Jointing Qualifications: Submit details of the proposed cable jointers qualifications prior to work commencing on site.

F. Tests and Certificates: Submit complete certified manufacturer's type test records for cables and accessories in accordance with the Standards.

G. Point-wise compliance statement to the specifications, duly signed by the manufacturer / manufacturer’s authorized representative and the contractor.

H. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

I. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

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J. Product Test Reports: Indicate compliance of cables and accessories with requirements based on comprehensive testing of current products.

K. Maintenance Data: For cables and accessories to include in the maintenance manuals specified in Division 1.

1. Include periodic tests of cables in service.

330.000 EXECUTION

330.010 EXAMINATION

A. Examine raceways to receive medium-voltage cables for compliance with requirements for installation tolerances and other conditions affecting performance of cables. Do not proceed with installation until unsatisfactory conditions have been corrected.

330.020 INSTALLATION

A. Install cables as indicated, according to manufacturer's written instructions.

B. Clamps: Where cables are fixed to supporting structures, approved galvanized cast steel clamps (or nonmagnetic clamps for single core cables) shall be used at distances not exceeding 20 diameters unless otherwise recommended by the clamp manufacturer through certification document from the manufacturer substantiated with necessary test certificate and / or calculations.

C. Cables Fixation on Cable Ladders: Use trefoil cleats for fixation on cable ladders for all single core cables in trefoil arrangement, trefoil cleats shall be used for all horizontal and vertical installations whether on racks, ladders, etc. For multi core cables, cleats shall be used for vertical installation on cable racks, ladders, etc. Spacing between cable cleats for horizontal, vertical and bend installations shall not exceed 450 mm unless otherwise recommended by the cleats manufacturer through certification document from the manufacturer substantiated with necessary test certificate and / or calculations.

D. Pull Conductors: Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

E. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceways. Do not use rope hitches for pulling attachment to cable.

F. Install exposed cables, parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

G. Support cables according to Division V Section "Basic Electrical Materials and Methods."

H. Install direct-buried cables on leveled and tamped 75-mm bed of clean sand at bottom of trench. Separate cables crossing other cables or piping from those items by a minimum of 100 mm of tamped earth. Install permanent markers at ends of cable runs, changes in direction, and buried splices.

I. Install "buried cable" warning tape 305 mm above cables.

J. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.

K. Seal around cables passing through fire-rated elements using approved fire-stopping material according to Division P Section " Fire Stopping Systems ".

L. Identify cables according to Division V Section "Basic Electrical Materials and Methods."

330.030 CABLE JOINTING AND TERMINATING

A. Through joints will not be allowed in feeder cables where adequate manufacturer's lengths are available. Where a joint is necessary, it has to be made inside boxes, handholes or manholes.

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B. Recommendations: Through joints and terminations shall be carried out strictly in accordance with cable manufacturer's recommendations, and made with correct specified materials, boxes, tapes, compounds or mixtures, stress cones, glands and bonds as applicable.

C. Jointing: Qualifications of operatives shall be submitted to Engineer prior to work commencing on site. Joints shall be filled with epoxy resin after taping unless contrary to cable manufacturer's recommendations. Sample site constructed cable terminations and through-joints shall be submitted to the Engineer prior to commencing work on site. Samples shall be constructed in the presence of the Engineer and shall be available for test and inspection in accordance with manufacturer's recommendations.

D. Cutting tools for jointing and terminating cables shall be purpose made, to prevent damage to insulation in general, and to cable shielding of MV cables.

E. Cleaning of lacquer on conductors shall be by use of 'Scotch Brite' sponge and white spirit or equal approved.

F. Tighten electrical connectors and terminals including screws and bolts, in accordance with manufacturers published torque-tightening values. Where manufacturer’s torquing requirements are not indicated, tighten connectors and terminals to comply with international standards.

330.040 FIELD QUALITY CONTROL

A. Cable tests shall be carried out in accordance with the requirements of the Regulations and Standards.

B. Test Equipment: Provide megger testers of various ranges as applicable, and HV test equipment as necessary for testing MV installations. Use 5000 V megger on MV installations for initial checks.

C. Testing: On installation of medium-voltage cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. MV Cable Testing: Provide cable test set with D.C. output voltage and ampere range sufficient to test MV cables. Cables shall be laid in position (trench or duct bank), jointed where applicable, but left uncovered, with ends free of equipment and clear of ground.
2. MV Cable Testing: D.C. test voltage shall be applied between core under test and the screen in steps, pausing one minute or more each step (first step being the A.C. RMS rated voltage of the cable, followed by two equal steps) up to maximum test voltage. At each step, and for the last 5-15 minutes duration at maximum test voltage, the ammeter (normally a micro-ammeter) shall be monitored closely and recorded. If, except as voltage is increased, the current starts to increase, test shall be stopped and the installation inspected and tested for the fault.
3. MV Cable Testing: Each cable/core shall be tested independently. Maximum D.C. test voltage for grounded neutral system shall be 3 times rated A.C. rms voltage of cable.
4. MV Cable Testing: Alternative test shall apply A.C. rms voltage up to 1.5 times A.C. rms rating of cable (26 kV for 17.5 kV cable and 54 kV for 36 kV cable), applied for 15 minutes, by an approved A.C. test set. Readings shall be within same range and in accordance with IEC 60502.

D. Correct malfunctioning cables and accessories at Project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

330.050 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, to prevent entrance of moisture into the cables and to ensure medium-voltage cables are without damage or deterioration at the time of Substantial Completion.

END OF SECTION Y61A

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PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. This Section includes low voltage (LV) feeder cables, branch circuit wiring, control and signal cables, termination, jointing and splicing.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Standards: Wires and cables shall comply with IEC or other equally approved standards and shall bear the mark of identification of the Standards to which they are manufactured. Wires and cables not having this identification will be rejected.

120.000 SYSTEM DESCRIPTION

120.010 GENERAL

A. Conductors: Unless otherwise specified or shown on the Drawings, cables and other feeders shall have copper conductors. Cable conductors shall be stranded for sections 2.5 mm2 and above,, annealed, electrolytic copper conductors based on IEC 60228 Class 2 for low voltage cables and class 5 to IEC 60228 for flexible cables. Signal and control cables shall have solid conductors unless otherwise specified. Flexible cords shall have finely stranded conductors. Conductors of single-core cables 25-mm^2 and above shall be compacted. Multi-core cables 35-mm^2 and above shall be sectorial shape.

B. Conductor sizes shall be metric and as shown on the Drawings. Conductors with cross-sectional area smaller than specified will not be accepted.

C. Low voltage cables, cable terminations and building wiring insulation shall be color coded or otherwise identified as required by the Regulations and as follows:

1. Neutral shall be blue.
2. Protective earth shall be green/yellow striped.
3. Phase colors shall be brown, black, grey or use color coding in accordance with local regulations and standards.

D. Maintain color coding throughout installation. Phase-conductors for which outer jacket is not color-coded shall have engraved alphanumeric mark (L1, L2, L3) or color coded heat-shrinkable sleeves.

E. Buried Cables: Cables buried directly in the ground shall be armored type, unless otherwise indicated in particular Sections of the Specification or on the Drawings.

F. Water tight cables shall be used for buried cables in high water content soil where indicated on the drawings shall be provided with water blocking swellable tape above insulation as longitudinal water barrier, PE laminated aluminum foil longitudinally applied with suitable overlap as radial water barrier and an external outer sheath made of extruded black medium density polyethylene compound. As an alternative, subject to Engineer’s approval, tree retardant cross linked polyethylene (XLPE/TR) to ASTM D6097 insulated cables with an external outer sheath made of extruded black medium density polyethylene compound can be used.

G. Outdoor cables exposed to sunlight shall be provided with ultraviolet resistant PVC sheath having 2.5% black carbon content.

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120.020 LV WIRES AND CABLES

A. Single Core PVC Insulated Non-Sheathed Cables (Protective Earth Cable): Single conductor cables used as protective earth shall have annealed copper conductors, compacted, generally with concentric strands and insulated with flame retardant insulation to IEC 60332-1, moisture and heat resistant PVC/E to IEC 60227-1 and IEC 60227-3, suitable for wet locations and with conductor temperature of 70 deg. C. Cable shall have harmonized cable code H07V-R for stranded cables and H07V-K for flexible conductors for fixed installations to BS EN 50525-2-31 and shall be marked in accordance with BS EN 50525-1. Wires and cables shall be 450/750 V grade.

B. Single Core Low Smoke Zero Halogen Cross Linked (LS0H-XL) Insulated Non-Sheathed Cables (Building Wires): Unless otherwise specified, single conductor cables for wiring installed in trunking in air plenum areas shall have annealed copper conductors, compacted, generally with concentric strands and insulated with moisture and heat resistant LS0H-XL material type EI 5 to BS EN 50363-5 and with conductor temperature of 90 deg. C. Cable shall have flame retardant insulation to IEC 60332-1. Cable shall have harmonized cable code H07Z-R for stranded cables and H07Z-K for flexible conductors for fixed installations to BS EN 50525-3-41 and shall be marked in accordance with BS EN 50525-1. Cable shall comply with IEC 61034 and IEC 60754. Wires and cables shall be 450/750 V grade.

C. Multi-Core PVC Insulated Cables (0.6/1 kV): To have annealed, copper conductors, compacted, insulated with PVC/A to IEC 60502-1, moisture and heat resistant, suitable for wet locations and conductor temperatures of 70 deg. C, laid up, bedded with suitable filler and sheathed with flame retardant PVC/ST2. Armored cables shall have single layer of galvanized steel wire armor with flame retardant PVC/ST2 over-sheath. Cables shall comply with IEC 60332-3, and IEC 60811.

D. Single Core XLPE Insulated Feeder Cables (0.6/1 kV): Single-core circular stranded, annealed copper conductors, compacted, insulated with moisture and heat resistant cross-linked polyethylene (XLPE), suitable for wet locations and conductor temperatures of 90 deg. C. and flame retardant PVC/ST2 over-sheath. Armored cables shall have taped bedding, single wire aluminum armor and flame retardant PVC/ST2 over-sheath. Cables shall comply with IEC 60502-1, IEC 60332-3, and IEC 60811.

E. Multi-Core XLPE Insulated Feeder Cables (0.6/1 kV): Multicore annealed copper conductors, compacted, XLPE insulated, for conductor temperature of 90 deg. C, laid up and bedded with suitable non-hygroscopic material compatible with the insulation and flame retardant PVC/ST2 over-sheathed, color black. Armored cables shall have single layer of galvanized steel wire applied helically over extruded flame retardant PVC/ST2 bedding (which may be an integral part of filling) and over-sheathed with flame retardant PVC/ST2, color black. Cables shall comply with IEC 60502-1, IEC 60332-3, and IEC 60811.

F. Multi-Core Dual Shielded XLPE Insulated Feeder Cables (minimum 0.6/1 kV) for Variable Frequency Drives (VFD): To have stranded copper conductors, class 5 to IEC 60228, compacted, adequately thick XLPE insulated, for conductor temperature of 90 deg. C. An overall tinned copper braided screen in conjunction with an aluminium/polymer tape shield shall be provided to achieve transfer impedance not exceeding 100 mOhm/m in the frequency range up to 100 MHz calculated in accordance with IEC 61196-1 or ANSI/NEMA WC 61. Cable shall have a flame retardant PVC/ST2 or LS0H over-sheath as shown on the drawings, LS0H over-sheath shall comply with IEC 61034 for low smoke emission, IEC 60754-1 for halogen acid gas content and IEC 60754-2 for degree of acidity of evolved gas, color black. Each feeder shall be provided with 3 nos. symmetrically arranged grounding conductors except for feeders less than 16 mm2 which shall be four core having the fourth core acting as a ground conductor. Cables shall be used with variable frequency drive applications. Cable length shall not exceed 40 m unless proper common mode, (dv/dt), or sinus filters are specified in the VFD, or as otherwise recommended by the manufacturer and approved by the Engineer. Cables shall comply with IEC 60092 or IEEE 1580, IEC 60502-1, IEC 60332-3, and IEC 60811.

G. VFD Cables Feeding Life Safety Equipment (Such as smoke / pressurization fans, etc.): Class 2 to IEC 60228, fire resistant type to IEC 60331-21 with LS0H over sheath to IEC 61034 for low smoke emission, IEC 60754-1 for halogen acid gas content and IEC 60754-2 for degree of acidity of evolved gas.

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H. Low Smoke Zero Halogen (LS0H) Cables: 600/1000 V grade, copper conductor, compacted, insulated with extruded material to IEC 61034 for low smoke emission, IEC 60754-1 for halogen acid gas content and IEC 60754-2 for degree of acidity of evolved gas. Cores and cross sectional area shall be as shown on the Drawings. Phases shall be color coded in conformity with the Standards, and overall cable sheath shall be extruded black LS0H material. Cables shall comply with IEC 60332-3.

I. Single Core Low Smoke Zero Halogen Cross Linked (LS0H-XL) Insulated Non-Sheathed Cables (Protective Earth Cables): Single conductor cables used as protective earth shall have annealed copper conductors, compacted, generally with concentric strands and insulated with moisture and heat resistant LS0H-XL material type EI 5 to BS EN 50363-5 and with conductor temperature of 90 deg. C. Cable shall have flame retardant insulation to IEC 60332-1. Cable shall have harmonized cable code H07Z-R for stranded cables and H07Z-K for flexible conductors for fixed installations to BS EN 50525-3-41 and shall be marked in accordance with BS EN 50525-1. Cable shall comply with IEC 61034 and IEC 60754. Wires and cables shall be 450/750 V grade.

J. Flexible cable for connection to appliances, window fans, pendants etc. shall be 300/500 V grade to IEC 60227-5, class 5 to IEC 60228, three or four core, with tinned finely stranded copper wires, heat resistant with PVC/E insulation and PVC/ST10 sheath. As an alternative, EPR insulation, twisted and sheathed with Chlorosulphonated Polyethylene (CSP) compound and with strengthening cord may be used.

K. Fire resistant LS0H Cable (abbreviated as FR1 on the drawings, similar to Prysmian - Type FP 100, or approved equal): Single core stranded plain annealed copper conductors to IEC 60228, fire resistant insulation category CWZ to BS 6387 for sizes up to 6 mm2, PH120 classified to BS EN 50200, and 120 minutes rating when tested in accordance with BS 8434-2 when tested in 20 mm rigid steel conduit and Low Smoke Zero Halogen (LS0H) composite sheath to IEC 61034 and IEC 60754. Cable shall comply with IEC 60332-1 & 3 (category C) for flame retardant properties. Cable shall comply with BS EN 50363 and rated 450/750 V, capable of accepting voltage surges up to 5 kV, operating conductor temperature of 90 deg. C. Cable shall be LPCB and BASEC certified, audited and marked by embossing on cable sheath . Cable shall be used as branch circuits installed in steel conduits for use in central battery system, smoke curtains and other similar loads where shown on the drawings.

L. Fire resistant LS0H Cable (abbreviated as FR2 on the drawings, similar to Prysmian - Type FP 300, or approved equal): Multi core solid or stranded plain annealed copper conductors to IEC 60228 (in sizes up to 16 mm2), dual layer insulation with fire resistant tape primary insulation layer and XLPE secondary insulation layer, category CWZ to BS 6387, complying with BS EN 50363, LS0H composite sheath with tinned earth continuity conductor/drain wire to IEC 61034 and IEC 60754. Cable shall comply with IEC 60331 for fire resistant characteristics at an enhanced temperature of 950 deg. C. and shall comply with IEC 60332-1-2 for flame retardant properties. Cable shall be rated 600/1000 V, capable of accepting voltage surges up to 5 kV, operating conductor temperature of 90 deg. C. Cable shall be LPCB and BASEC certified, audited and marked by embossing on cable sheath. Cable shall be installed in steel conduits for use in main incoming cable in central battery system and other life safety equipment where shown on the drawings.

M. Fire resistant LS0H Cable (abbreviated as FR3 on the drawings, similar to Prysmian - Type FP 200 Gold, or approved equal) : Multi core solid or stranded plain annealed copper conductors to IEC 60228 (in sizes up to 4 mm2), fire resistant insulation, galvanized steel wire armored, category CWZ to BS 6387, PH60 classified to BS EN 50200, and 30 minutes rating when tested with additional water spray in accordance BS EN 50200 Annex E and complying with BS EN 50363, laminated aluminum screen and LS0H composite sheath with tinned earth continuity conductor/drain wire to IEC 61034 and IEC 60754. Cable shall comply with IEC 60332-1 & 3 (category C) for flame retardant properties. Cable shall be rated 300/500 V, capable of accepting voltage surges up to 5 kV, operating conductor temperature of 70 deg. C. Cable shall be LPCB and BASEC certified, audited and marked by embossing on cable sheath. Cable shall be used for fire alarm, voice evacuation installations, branch circuits in central battery system and other loads requiring category 1 circuits in accordance with BS 8519 including buildings with evacuation time not exceeding 30 minutes unless otherwise specified under fire alarm section and where shown on the drawings.

N. Fire resistant LS0H Cable (abbreviated as FR4 on the drawings, similar to Prysmian - Type FP Plus, or approved equal) : Multi core plain annealed copper conductors to IEC 60228 (in sizes up to 4

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mm2), fire resistant insulation, galvanized steel wire armored, category CWZ to BS 6387, PH 120 classified to BS EN 50200, and 120 minutes rating when tested in accordance with BS 8434-2 and complying with BS EN 50363, laminated aluminum screen bonded to the sheath and LS0H composite sheath with tinned earth continuity conductor/drain wire to IEC 61034 and IEC 60754. Cable shall comply with IEC 60332-1 & 3 (category C) for flame retardant properties. Cable shall be rated 300/500 V, capable of accepting voltage surges up to 5 kV, operating conductor temperature of 70 deg. C. Cable shall be LPCB and BASEC certified, audited and marked by embossing on cable sheath. Cable shall be used for fire alarm, voice evacuation installations, emergency voice communication systems, branch circuits in central battery system and other loads requiring category 2&3 circuits in accordance with BS 8519 including buildings with evacuation time higher than 30 minutes, such as high assembly and high rise buildings unless otherwise specified under fire alarm section and where shown on the drawings.

O. Fire resistant LS0H Cable 600/1000 V, (abbreviated as FR5 on the drawings, similar to Prysmian - Type FP-400, or approved equal): Multi core plain copper stranded circular or shaped conductor (sizes up to 400mm^2) complying with IEC 60228 with fire resistant insulation category CWZ to BS 6387, category F2 to BS 7846, PH60 classified to BS EN 50200 and 30 minutes rating when tested with additional water spray in accordance with BS EN 50200 Annex E and complying with BS EN 50363 operating conductor temperature 90ºC, single galvanized steel wire armour and extruded low smoke zero halogen (LS0H) over sheath wire to IEC 61034 and IEC 60754. Cable shall comply with IEC 60332-1 & 3 (category C) for flame retardant properties. Cable shall be LPCB and BASEC certified, audited and marked by embossing on cable sheath. Cable shall be used for feeders of the fire pumps, smoke and pressurizing fans, fire fighting elevators and other firefighting and life safety loads requiring category 1 circuits in accordance with BS 8519 including buildings with evacuation time not exceeding 30 minutes and where shown on the drawings.

P. Fire resistant LS0H Cable 600/1000 V, (abbreviated as FR6 on the drawings, similar to Prysmian - Type FP-600S, or approved equal): Multi core plain copper stranded circular or shaped conductor (sizes up to 400 mm^2) complying with IEC 60228 with fire resistant insulation category F120 to BS 7846 and tested in accordance with BS 8491 and complying with BS EN 50363 operating conductor temperature 90ºC, single galvanized steel wire armour and extruded low smoke zero halogen (LS0H) over sheath wire to IEC 61034 and IEC 60754. Cable shall comply with IEC 60332-1 & 3 (category C) for flame retardant properties. Cable shall be LPCB and BASEC certified, audited and marked by embossing on cable sheath . Cable shall be used for feeders of the fire pumps, smoke and pressurizing fans, fire fighting elevators and other firefighting and life safety loads requiring category 2&3 circuits in accordance with BS 8519 including buildings with evacuation time higher than 30 minutes, such as high assembly and high rise buildings and where shown on the drawings.

Q. Fire resistant LS0H Cable (abbreviated as FRE on the drawings, similar to Prysmian - Type FP 100, or approved equal): Single core stranded plain annealed copper conductors to IEC 60228, fire resistant insulation to IEC 60331 and Low Smoke Zero Halogen (LS0H) composite sheath to IEC 61034 and IEC 60754. Cable shall comply with IEC 60332-1 & 3 (category C) for flame retardant properties. Cable shall comply with BS EN 50363 and rated 450/750 V for sizes up to 10 mm2 and 600/100 V for sizes greater than 10mm2, capable of accepting voltage surges up to 5 kV, operating conductor temperature of 90 deg. C. Cable shall be LPCB and BASEC certified, audited and marked by embossing on cable sheath. Cable shall have green/yellow striped color and shall be used as earth conductor for fire resistant feeders.

120.030 CONTROL AND SIGNAL CABLES

A. Multi-Core PVC Insulated Control Cables: 0.6/1 kV rating, solid 1.5 mm2, 2.5 mm2 or stranded 4 mm2 plain circular copper conductors, with heat resistive PVC/A to IEC 60502-1, rated for 70 deg. C, of 7, 12, 19, 24, 30 or 37 cores. Cores shall be laid up together and filled with non-hygroscopic material, and covered with copper wire or tape screen and over sheathed with flame retardant PVC/ST1, to form compact and circular cable for use in switchgear, control gear and generally for control of power and lighting systems. Armored cable shall have extruded PVC bedding which may be an integral part of the filling, galvanized steel wire armoring, and over-sheath of flame retardant PVC/ST1 to IEC 60502-1 and IEC 60332-1, color black. Core identification shall be white printed numbers 1, 2, 3 etc. over black insulation.

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B. Cables for life safety and fire fighting systems shall be certified to have passed IEC 60331 fire resistance and IEC 60332-1 flame retardance and reduced flame propagation to category CWZ of BS 6387.

C. PE insulated control and signal cables, for use on data systems, shall be generally 300 V rating, polyethylene insulated, color-coded, tinned copper conductors (0.6-mm diameter), twisted together into pairs. Multi-pair core assembly shall be covered with binder tape, spirally wound 0.075-mm bare copper shielding tape and provided with drain wire and overall PVC sheath.

D. Control and signal cables, enclosed in conduit and raceways with power cables, shall be insulated for same voltage grade.

E. Multi core PVC insulated cables (300/500 V) annealed copper conductors, solid conductors, up to 4 mm^2 unless otherwise indicated, insulated with moisture and heat resistant PVC/C to IEC 60227 and with over sheath of flame redundant PVC type ST1 to IEC 60227 and IEC 60332-1.

120.040 TERMINATION AND SPLICE CONNECTORS (LV POWER)

A. Connector terminations and splices shall be of class A to IEC 61238-1.

B. Connectors shall be compression, barrel crimped type.

C. Connectors for copper conductors shall be made of electrolytic copper.

D. Connectors for aluminum conductors shall be made of aluminum alloy of purity not less than 99.5%.

E. All termination and splice connectors specified above shall be tin plated with minimum thickness of 5 microns for copper material and 7 microns for aluminum material. Aluminum connectors shall incorporate neutral grease to avoid aluminum oxidation

F. Termination connectors for aluminum-copper termination shall consist of barrel made of aluminum alloy of purity not less than 99.5% and palm made of forged copper connected using a friction stir welding.

G. Splice connectors for aluminum-copper termination shall consist of two barrels, one is made of electrolytic copper and the other is made of aluminum alloy of purity not less than 99.5% connected using a friction stir welding.

H. Splice connectors shall have a central stop to divide the connector into two equal parts to facilitate the correct cable positioning.

I. Connectors shall be as recommended by manufacturer, to render joints equal to cable in characteristics, in terms of insulation, stress distribution and water-tightness. Materials and methods of jointing shall be approved before confirmation of order.

J. Connectors shall be suitable for cable size used.

K. Connector - Type A-1: Heat shrinkable or cold shrinkable for making T-taps and splices on conductors used in external lighting fittings connections.

L. Connector - Type A-2: Pressure indent type, for terminating or making T-taps and splices on conductors 10 mm2 and smaller. Connector shall be non-ferrous copper alloy applied to conductor by mechanical crimping pressure, with vinyl insulating sleeves or phenolic insulating covers.

M. Connector - Type A-3: Bolted pressure split type for terminating or making T-taps and splices on conductors 16 mm2 and larger. Connector shall be cast non-ferrous copper alloy applied to conductor by clamping with minimum of two screws and provided with phenolic insulating cover.

N. Connector - Type B-1: Pre-insulated, spring type, for branch circuit and fixture wiring. Connector shall be steel encased spring with shell, insulated with vinyl cap and skirt.

O. All components of lugs and connectors shall be clearly marked with the manufacturer’s name, die number, cable / conductor size, number of crimps and position.

120.050 CABLE GLANDS

A. Cable glands shall comply with BS 6121-1, BS 6121-5 and IEC 62444.

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B. Cable glands used with unarmored cables shall be made of brass, type A2 to BS 6121-5, with mechanical retention Type B to IEC 62444, impact resistance category 8 to IEC 62444 and an environmental seal to the cable outer sheath. Glands shall be deluge protected, with IP66 degree of protection to IEC 60529.

C. Cable glands used with single steel wire armored cables shall be made of brass, type CW to BS 6121-5, with mechanical retention Type D to IEC 62444, impact resistance category 8 to IEC 62444, connection to protective earth category B to IEC 62444 and shall be capable of passing an earth fault current, earth tag to IEC 62444 and an environmental seal to the cable outer sheath. Glands shall have IP66 degree of protection to IEC 60529.

D. Cable glands used with steel tape or wire braid armor shall have similar characteristics as specified in paragraph 120.050 C except gland type which shall be CX instead of CW to BS 6121-5.

E. Cable glands used with single steel wire armored cables where sprinkler / water mist firefighting systems are used shall be made of brass, type E1W to BS 6121-5, with mechanical retention class B to IEC 62444, impact resistance category 8 to IEC 62444, electrical continuity via armor wire termination category B to IEC 62444, earth tag to IEC 62444 and an environmental seal to the cable inner and outer sheaths. Glands shall be deluge protected, with IP66 degree of protection to IEC 60529.

F. Cable glands used with steel tape or wire braid armor shall have similar characteristics as specified in paragraph 120.050 E except gland type which shall be E1X instead of E1W to BS 6121-5.

G. Cable glands for use in explosive hazardous areas shall be flame proof with protection Ex d to IEC 60079-1 and have same applicable characteristics according to cable type as above.

H. Stainless steel grade 316 cable glands shall be used in installations in chemical and extremely corrosive areas and where stainless steel enclosures are used. Glands shall have same applicable characteristics according to cable type as above.

I. Aluminum cable glands shall be used for cables with aluminum wire armor. Glands shall have same applicable characteristics according to cable type as above.

J. Cable glands used with LS0H or fire resistant cables shall be of the applicable type as stated above and provided with low smoke fume shroud.

K. Cable glands used for outdoor terminations shall be of the applicable type as stated above and provided with non-deteriorating, UV stabilized seal and shroud.

L. Cable glands shall be suitable for cable size used.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and Division A Specification Sections, apply to this Section.

210.000 RELATED SECTIONS

A. Related Sections include the following:

1. Division P Section “Fire Stopping Systems’’
2. Division V Section "Basic Electrical Materials and Methods".
3. Division Y Section "Cable Trays for Electrical Systems" with its related sections.
4. Division Y Section "Raceways and Boxes for Electrical Systems" with its related sections.

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PART 3 PRODUCTS AND WORKMANSHIP

300.000 MATERIALS

300.010 MANUFACTURERS

A. Approved Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

1. Low Voltage Cables:

a) B.I.C.C.
b) Nexans
c) Prysmian
d) Lapp Kabel
e) General Cables
f) Belden
g) The Okonite Co.
h) Draka
i) Bahra Cables
j) Ducab

2. Low Voltage Variable Frequency Drive Cables:

a) Lapp Kabel
b) Nexans
c) Prysmian
d) Leoni
e) Belden
f) General Cables

3. Low Voltage Fire Resistant Cables:

a) Prysmian
b) Nexans
c) Bahra Cables
d) Ducab
e) Draka

4. Cable Connectors:

a) Raychem
b) 3M
c) B.I.C.C.
d) Nexans
e) Prysmian
f) Klauke

5. Cable Glands:

a) CMP
b) Hawke
c) Stahl
d) Thomas & Betts
e) Prysmian

300.020 PRODUCTS

A. Products: Subject to compliance with requirements, provide one of the products indicated for each designation as shown on plans.

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310.000 QUALITY MANAGEMENT

310.010 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced and certified cable splicer to install, splice and terminate low-voltage cables.

B. Current carrying capacities of conductors have been determined in accordance with the Regulations for specified type of insulation and expected conditions of installation. No change will be accepted in specified type of insulation unless warranted by special conditions and approved by Engineer. Check various loads and current carrying capacities and report any discrepancies or insufficiency of sizes indicated to Engineer.

310.020 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle wires and cables as per Manufacturer’s instructions.

310.030 COORDINATION

A. Coordinate layout and installation of cables with other installations.

B. Revise locations and elevations from those indicated, as required to suit field conditions and as approved by Engineer.

320.000 SUBMITTALS

A. Technical Data: Submit data for approval including, but not limited to, the following:

1. Constructional details, standards to which cables comply, current carrying capacities, de-rating factors for grouping and temperature.
2. Manufacturer's catalogue cuts.
3. Dimensional and electrical characteristics.
4. Manufacturer's drawings showing the outline of the lugs and sleeve connectors together with all pertinent dimensions. Any variation in these dimensions due to manufacturing tolerances shall be indicated.

B. Samples of each cable and wire and, if requested by Engineer, other accessories.

C. Shop and Construction Drawings: Submit drawings for approval including, but not limited to, the following:

1. Exact routing layouts, sections and profiles of trays, feeder, sub-feeder cables and branch circuits, with indication of any equipment to show and verify coordination between various trades.
2. Cable sizing calculation including current carrying capacities, de-rating factors for grouping and temperature and voltage drop calculations.
3. Details of supports and fixings for buses, trays and cables.
4. Details of connections to transformers, switchboards, panelboards etc.
5. Details of terminations, splices and tapings where permitted, glands and bushings at enclosures.
6. Number and size of conductors in conduit for all branch circuits in accordance with final conduit routing.
7. Cable schedule including cable reference, originating and terminating points’ references along with feeder data showing load current and cumulative voltage drop at feeder end.
8. Cable terminations (and joints, if any) schedule.

D. Certificate of Origin: For each lot of cable supplied, provide a certificate of origin issued by manufacturer stating origin, date of manufacture, composition, standards to which it complies and test certificates. All test certificates shall comply with the test requirements of the relevant standard to which the cable is manufactured.

E. Tests and Certificates: Submit complete certified manufacturer's type test records for cables and accessories in accordance with the Standards.

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F. Point-wise compliance statement to the specifications, duly signed by the manufacturer / manufacturer's authorized representative and the contractor.

G. Cable Jointing Qualifications: Submit details of the proposed cable jointers qualifications prior to work commencing on site.

H. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

I. As-Built (Record) Drawings: At Project Close-Out, submit, certified by Consultant, Record Drawings of installed electrical systems, indicating all existing services and those installed, in accordance with requirements of the Specification.

J. Routine tests at factory: All cables shall be subjected to factory routine test prior to shipment as required by the relevant standard. Routine test certificates shall be properly numbered and submitted with shipment.

330.000 EXECUTION

330.010 EXAMINATION

A. Examine raceways and building finishes receiving wires and cables for compliance with requirements for installation tolerances and other conditions affecting performance of wires and cables. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Before pulling wires in conduit check that inside of conduit (and raceway in general) is free of burrs and is dry and clean.

330.020 INSTALLATION

A. General

1. General: Building wires and cables shall be installed in conduit, trunking or ducts indoors and in conduit outdoors, unless otherwise shown the Drawings.
2. Circuits: Unless otherwise shown on the Drawings, final branch circuit wiring shall be run inside trunking or conduits, D.C. wiring shall be run in separate conduits from A.C. wiring, and emergency lighting and power circuits shall be run in separate conduits from normal circuits.
3. Branch circuit work originating from light and power panelboards shall be arranged as shown on the Drawings. Loads on various phases of panelboards shall be balanced. Ensure that the lighting load and other loads are balanced with a difference of not more than 10% between the phases.
4. Control cables may be fixed to racks, installed directly on cable trays or pulled in conduit and trunking indoors, and in underground ducts or in conduit outdoors.
5. Bunching of wires in raceways shall be in accordance with raceway filling factors permitted by the Regulations.
6. Lubricants shall be used for pulling wire or cable if character of pull would otherwise damage conductors, insulation or jacket. Lubricants shall be approved by the Engineer.
7. Pull conductors into raceways simultaneously where more than one is being installed in the same raceway.
8. Support: Cables and wires pulled inside very high conduit risers shall be supported at upper end of risers and at intermediate points by split rubber grommets to relieve any stresses on conductors, where required.
9. Wiring at Outlets: Leave a slack of at least 200mm at each outlet.
10. Extra Length: At every branch circuit outlet and pull-box, every cable passing through shall be left slack to allow inspection and for connections to be made. Cables terminating in outlet boxes shall be left with at least 250-mm extra length for terminations.
11. Joints or taps in wires and cables, if permitted, shall be permanently accessible or made only in boxes or cabinet gutters.
12. Insulating covers shall be applied to prevent exposure of bare cable connections.
13. Switch legs for local wall switches shall have distinctive color, selected as complementary to cable color coding used in the project.

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14. Terminations: Conductors of wires and cables up to 6 mm2 for copper conductors and up to 10 mm^2 for aluminum conductors shall be tightly twisted and where possible doubled back before being clamped with set screws. Where two or more wires are looped into same terminal these conductors shall be tightly twisted together before inserting into terminals. As an alternative, fork / ring, compression / twisting type connectors may be used for cable termination. In no case bare conductor shall be allowed to project beyond any insulated shrouding or mounting of a line terminal. Cables sizes 10 mm2 and larger for copper conductors and 16 mm2 and larger for aluminum conductors shall terminate in compression lug connectors.
15. Cable on cable racks, in cable trays and upon emerging from conduits shall be formed to avoid bearing against edges of trays, racks, conduits or their supports upon entering or leaving trays, racks or conduits. Cables in horizontal runs in trays shall be tied by 3mm nylon cord to the cable trays. Sequence of cables transversely in trays shall avoid unnecessary crossing of other cables when some of the cables make turns into lateral trays, or upon entering or leaving a run of tray.
16. Tagging: Tag main and feeder cables in pull-boxes, wireways and wiring gutters of panelboards or distribution cabinets. Tags shall identify cable or circuit number and conductor size in accordance with the Schedules.
17. Tagging: Where two or more circuits are run to or through a control device, outlet box or ceiling junction box, each circuit shall be tagged as a guide in making connections.

B. FEEDER AND SUB-FEEDER INSTALLATION (0.6/1 KV)

1. Cables generally shall be run through duct-banks, shafts or special recesses, clamped to steel racks or cable trays. Cables run through ventilation shafts shall be LS0H type or installed in steel conduits.
2. Fixing: Single cables above suspended ceilings or in concealed spaces shall be fixed directly to walls or ceilings but must be accessible. Where two or more cables are run in parallel, they shall be fixed on galvanized steel perforated trays or on other approved special cable supporting and protecting arrangement.
3. Clamps: Where cables are fixed to steel trays or supporting structures, approved galvanized cast steel clamps (or nonmagnetic clamps for single core cables) shall be used at distances not exceeding 20 diameters.
4. Joints or splices will not be accepted on main and sub-feeders. Cables shall be supplied in lengths sufficient for straight-through un-jointed termination to termination pull.
5. Directly buried cables crossing under roads, pipe banks or other services, shall be laid in heavy duty PVC duct banks. In no case are cables to be directly buried in concrete, in masonry or in floor finishing.
6. Buried cables liable to mechanical damage shall be drawn through PVC conduit or asbestos cement pipe. If steel conduit is used, all three-phase conductors, neutral and protective earth circuits shall be in the same conduit.
7. Exposure to Heat: Route wires and cables to prevent exposure to excessive heat or to corrosive agents. If such condition is unavoidable, cables shall be type designed for particular condition.
8. Insulating covers shall be applied to prevent exposure of bare cable connections. Insulating cover shall be purpose made and shall provide minimum insulation level equal to that of conductor insulation.
9. Glands for various single-core and multi-core cables shall be purpose made and suitable for rigid mounting to equipment enclosure.
10. Seal around cables penetrating fire-rated elements using approved fire-stopping material according to Division P Section " Fire Stopping Systems ".
11. Identify wires and cables according to Division V Section "Basic Electrical Materials and Methods."

C. CABLE CONNECTIONS, JOINTING AND TERMINATIONS

1. Through joints will not be allowed in feeder cables where adequate manufacturer's lengths are available. Where a joint is necessary, it has to be made inside boxes, handholes or manholes.
2. Recommendations: Through joints and terminations shall be carried out strictly in accordance with cable manufacturer's recommendations, and made with correct specified materials, boxes, tapes, compounds or mixtures, stress cones, glands and bonds as applicable.
3. Jointing: Joints shall be filled with epoxy resin after taping unless contrary to cable manufacturer's recommendations. Sample site constructed cable terminations and through-joints shall be submitted prior to commencing work on site. Samples shall be constructed in the

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presence of the Engineer and shall be available for test and inspection in accordance with manufacturer's recommendations.

4. Cutting tools for jointing and terminating cables shall be purpose made, to prevent damage to insulation in general.
5. Cleaning of lacquer on conductors shall be by use of 'Scotch Brite' sponge and white spirit or equal approved.
6. Tighten electrical connectors and terminals including screws and bolts, in accordance with manufacturers published torque-tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with international standards.

D. FIELD QUALITY CONTROL

1. Cable tests shall be carried out in accordance with the requirements of the Regulations and Standards.
2. Test Equipment: Provide megger testers of various ranges as applicable. Use 500 V megger on installations with nominal voltage up to 500 V, and 1000 V megger on installations with nominal voltage over 500 V up to 1000 V.
3. Insulation resistance for LV power and lighting installations shall be carried out in accordance with BS 7671 ("The IEE wiring Regulations").
4. Insulation resistance for control and signal cables shall be minimum 10000 Megohm-km for PE insulated cables and 100 Megohm-km for PVC insulated cables, all measured core-core and core-earth, in accordance with the Regulations.
5. Prior to energization of circuitry, check installed wires and cables with megohm meter to determine insulation resistance levels to ensure requirements are fulfilled.
6. Prior to energization, test wires and cables for electrical continuity and for short-circuits.
7. Subsequent to wire and cable hook-ups, energize circuitry and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

END OF SECTION Y61B

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Y62A - ENCLOSED BUS ASSEMBLIES

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. This Section includes busway assemblies and fittings.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Standards: Comply with the following standards:

1. IEC 61439-1 and IEC 61439-6.
2. IEC 60529.

120.000 SYSTEM DESCRIPTION

120.010 GENERAL REUIREMENTS

A. Busway shall be Plug-in type for tap off applications and feeder type for non tapped straight runs and direct connections between equipment, as applicable and / or shown on the Drawings, indoor, complete with manufacturer's recommended fittings and accessories where indicated and as required for a complete, functioning and safe installation .

B. Busway shall include bus bars, electrical insulators, enclosures, switchboard flange, elbows, offsets, cable tap boxes, transformer flange connections with flexible copper braid link, generator flange connection with flexible copper braid link and vibration absorber, power take-off sections, busway reducers with built-in circuit breaker, phase transposition, expansion joints, end closures, supports, and other components and accessories needed to form complete systems.

C. Ratings: three phase with voltage and current ratings and requirements for neutral and ground conductors as indicated and specified.

D. Busway Conductor Material: hard drawn Copper with not less than 98 percent conductivity .

E. Busways: tin plated for copper and insulated over entire length, with flame retardant 130 deg C class epoxy insulation.

F. Hot Spot Temperature Rise: not to exceed limits specified in the Standards which the busway is designed to at any point in the busway when busway is operated at rated load current and system frequency.

G. Current Densities of Busway Conductors: Rated current carrying capacities of the Busway shall not exceed the following:

1. 2.5A/mm2 for copper conductors rated below 2000A and 2.25A/mm2 for copper conductors rated 2000A and above.
2. 1.75A/mm^2 for aluminum conductors rated below 2000A and 1.55A/mm^2 for Aluminum conductors rated 2000A and above.

The above densities are at the temperature specified in the Standards which the busway is designed to and shall be derated at the site maximum ambient temperature conditions.

120.020 BUSWAY (225 TO 5000A)

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A. Type: Indoor, 600 V grade L-N, 3-phase, 4-wire (3P+N) for feeder busway from transformer to switchboard and 5-wire (3P+N+E) for other feeder type busways and for all plug in type busways, insulated, totally enclosed, non-ventilated and of compact design to provide degree of protection of IP65 to IEC 60529, with ratings as shown on the Drawings at site maximum ambient temperature conditions. Where indoor busway is partially running through outdoor / wet areas, these portions shall be IP65 rated. Neutral shall be fully sized as per the phase conductor, unless double neutral is required on the Drawings while internal earth bar shall be half sized the phase conductor without considering the contribution of the enclosure as earthing means. Short-circuit capacity shall be certified by an approved third party and shall be at least equal to the value at the upstream point of connection or as shown on the Drawings, whichever is greater, for 1 second.

B. Construction: Prefabricated, insulated flat copper conductors with purity not less than 98%, with minimum 2.5 mm extruded aluminum housing, totally enclosed, non-ventilated, sandwich type. Housing shall be bonderized inside and outside and finished with gray baked electrostatic paint, unless otherwise proposed by the supplier and approved by Engineer. Busbars shall be provided with extra insulation between busbars and housing along the full length. Joints between sections shall have special insulation, flanged and pressure bolted, easily dismantled and giving equally strong mechanical connection to busway sections. Any section of the busway shall be removable without disturbing adjacent sections. The busbar joint shall be of an approved type assembly, to maintain proper pressure over a large contact area.

C. Conductor joints for one modular length to the next shall be silver plated for Aluminum conductor busways and plated and arranged in joint stacks incorporating busway conductors, and each joint stack shall be arranged for tightening with a single bolt. Joint design shall be such that any length or fitting of a run may be removed without disturbing the connecting lengths.

D. Reactance: Busway shall be specially built and assembled to provide low reactance.

E. Accessories: Busway shall be complete with necessary factory made adaptor boxes, junction boxes, bends, expansion connections, fittings, fire barriers etc. as may be required to provide complete system between terminal points indicated on the Drawings. Fixing and mounting materials shall be galvanized steel. For vertically mounted busways, spring suspension type hangers shall be used for equalizing weight of trunking between all supports.

F. Cable Tap Boxes: Busways connected to cables at either ends or at plug-ins shall be provided with cable tap boxes to connect electrical cable to the busway distribution system.

G. Terminal adaptors or chambers shall be factory made. Coordinated components at both ends shall match equipment connected thereto. Connections shall be made with insulated copper bars of equivalent sections and of exact shapes to fit and be fixed with bolts and spring washers. The contractor is responsible for coordination between the two manufacturers.

H. Busway shall be ordered from the country of origin with proper lengths and shapes. Busway cutting on site is not acceptable.

I. Plug-In Openings: five, dead-front, hinged cover openings per side of each 3 m (10 ft) length of busway. Openings shall be useable simultaneously.

J. Phase Transposition: Busways intended to change the relative positions of the phase conductors in order to balance the inductive reactances or to transpose the phases shall be provided with phase transposition unit.

120.030 PLUG-IN DEVICES AND BUSWAY REDUCERS

A. General: Compatible with the connected busway and of types as indicated. Plug-in devices and reducers shall be equipped with spring reinforced contact fingers arranged so they will not make contact with busways during plug insertion until the device housing is positively earthed to the busway. Plug-in devices and reducers shall be locked in position mechanically and make positive earthing contact before to the power connection when in the fully inserted position. Safety interlocks (releasable) shall be provided on busway plugs and reducers having "on" and "off" positions to prevent insertion or removal of unit when the circuit breaker is in the closed position, prevent opening the cover when the circuit breaker is in the closed position and to prevent closing the circuit

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breaker when the cover is opened. Alignment tabs shall be provided to prevent the plug-in device or reducer from being installed 180° out of position. Mounting hardware shall be captive on bus plug housing.

B. Plug-in units (tap off units) shall be of rating shown on the Drawings, and comprise circuit breaker made by same manufacturer of the busway, unless otherwise approved by the Engineer, complete with stabs, stab shields and earthing stab. No cables are permitted for connection of the breaker to the busway stabs. Circuit breakers shall be as specified in Division Y Section "Panelboards".

C. Busway reducers shall be provided where shown on the Drawings and with the rating shown on the Drawings, and comprise circuit breaker made by same manufacturer of the busway, unless otherwise approved by the Engineer, complete with stabs, stab shields and earthing stab. No cables are permitted for connection of the breaker to the busway stabs. Circuit breakers shall be as specified in Division Y Section "Switchboards".

120.040 SUPPORTS AND ACCESSORIES

A. General: as recommended by busway manufacturer and conforming to Division V Section "Basic Electrical Materials and Methods".

B. Spring Mounted Vertical Riser Supports: Adjustable for leveling and spring tension and arranged to permit relative movement between floor and busway.

C. Rigid Floor Supports: Adjustable for leveling.

D. Expansion Section: Capacity and conductor provisions same as adjacent busway section. Arranged to absorb expansion and contraction of bus bars and housing.

E. Fasteners to connect busway supports to the building structure as follows:

1. Expansion Anchors: Carbon steel wedge or sleeve type.
2. Toggle Bolts: All steel spring head type.
3. Powder Driven Threaded Studs: Heat treated steel, designed specifically for the intended service.

120.050 FIRE STOPPING

A. General: Materials approved for fire ratings consistent with penetrated barriers. Refer to Division V Section "Basic Electrical Materials and Methods" and Division P Section "Fire Stopping Systems ".

B. Wall and Floor Flanges: Sheet steel, 2 mm (12-gage) minimum thickness close fitting to busway arranged to close the wall or floor opening at the busway penetration.

C. Two-Part Sealant: Formed-in-place sealant matching the type used during the fire resistance in building penetrations test in accordance with IEC 61439-6..

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and Division A Specification Sections, apply to this Section.

210.000 RELATED SECTIONS

A. Related Sections include the following:

1. Division V Section "Basic Electrical Materials and Methods".
2. Division Y Section "Low Voltage Electrical Power Conductors and Cables" for bus drop cables.
3. Division Y Section "Switchboards" for busway termination provisions.
4. Division V Section "Medium Voltage Transformers" for busway termination provisions.
5. Division W Section "Surge Protective Devices ".

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PART 3 PRODUCTS AND WORKMANSHIP

300.000 MATERIALS

300.010 MANUFACTURERS

A. Approved Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

1. EATON / Cutler-Hammer.
2. G. E.
3. Siemens / Sentron Busway
4. Schneider Electric / SquareD
5. Power Bar (PB)
6. LS

310.000 QUALITY MANAGEMENT

310.010 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed bus-assembly components and fittings through one source from a single manufacturer.

310.020 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, and handle bus assemblies according to Manufacturer's instructions.

310.030 WARRANTY

A. Manufacturer's Warranty: Submit a written warranty signed by the manufacturer agreeing to repair, restore or replace any defective equipment specified in this section during the specified warranty period

1. Warranty Period: 1 year from date of Substantial Completion.

310.040 SPARE PARTS AND EXTRA MATERIAL

A. Furnish extra materials described below that match product installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Plug-in Units: 2 percent of installed units, but not less than one unit of each type installed.
2. Hookstick operator for plug-in units.

320.000 SUBMITTALS

A. Technical Data: Include electrical ratings, dimensions, mounting position, mounting method, vertical supports, materials, firestops, and weatherstops for each component.

B. Point-wise compliance statement to the specifications, duly signed by the manufacturer / manufacturer's authorized representative and the contractor.

C. Shop Drawings: Detail fabrication and installation of enclosed bus assemblies including plans, elevations, sections, component details, and attachments to other construction elements. Detail connections to switchboards, transformers, panel boards and other electrical equipment. Detail supports and connections to building.

D. Coordination and Construction Drawings: Include floor plans and sections to show enclosed bus-assembly layouts and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

E. Type Test Certificates: Submit to verify compliance of the system with the relevant Standards.

F. Supporting System: Submit the following:

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1. Detail supporting system, including anchorages and attachments to structure and to supported equipment.

G. As-Built (Record) Drawings: At Project close-out, submit Record Drawings of installed enclosed bus assemblies, in accordance with requirements of the Specification, Division A.

H. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

I. Operation and Maintenance Data: For enclosed bus assemblies to include in emergency, operation, and maintenance manuals and to the satisfaction of the Employer's requirements.

330.000 EXECUTION

330.010 PROJECT CONDITIONS

A. Field Measurements: Verify existing dimensions by field measurements. Verify clearances and locate obstructions within manufacturing and installation tolerances of enclosed bus assemblies.

B. Products shall be suitably rated for Project conditions.

330.020 COORDINATION

A. Coordinate layout and installation of busway with other installations.

1. Revise locations and elevations from those indicated as required to suit field conditions and as approved by the Engineer.

330.030 INSTALLATION

A. Install busways and accessories as indicated and in compliance with applicable requirements of applicable codes/regulations. Conform to manufacturer's written instructions except where more stringent requirements apply.

B. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in the approved applicable standards. Tighten joints again after bus assemblies have been energized for 30 days.

C. Install expansion fittings at locations where bus assembly crosses building expansion joints. Install at other locations so distance between expansion fittings does not exceed 90 percent of manufacturer's recommended distance between fittings for the type and material of busway installed.

D. Fire Stops: Install fire stops where busway penetrates fire rated walls and floors. Seal between busway and opening and around opening with sealant or sealing mortar having fire rating not less than that of the penetrated wall or floor. Comply with Division P Section "Fire Stopping Systems ".

E. Weather Seal: Install integral weather seal where busway penetrates exterior wall or roof. Provide appropriate flange and seal around openings to make weather tight.

F. Floor Penetrations: Provide a minimum 100 mm (4-inch-high) curb around busway penetrations of floors to prevent water from spills and leaks from contacting busway.

G. Support busway from the building structure independently from other suspended items.

1. Conform to manufacturer's recommendations for selection, spacing, and installation of supports.
2. Strength of each support including fastenings to the structure shall be adequate to support busway load multiplied by a safety factor of three or 90 kg (200 lb), whichever is greater.
3. Support bus assembly to prevent twisting from eccentric loading.
4. Support bus assembly with not less than 10-mm steel rods for horizontal installations and with spring supports for vertical installations, unless otherwise by the Manufacturer and approved by the Engineer. Modify supports after completion to eliminate strains and stresses on bus bars and housings.

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5. Fasten supports securely to building structure according to Division V Section "Basic Electrical Materials and Methods."

H. Fastening Supports: Unless otherwise indicated, fasten supports securely to the building structure as specified in Division V Section "Basic Electrical Materials and Methods".

I. Support at Connections to Equipment: Where busways connect to equipment, provide flanged fittings fastened to the busway and to the equipment. Support the busway separately. Do not carry the weight of the busway on the equipment enclosure.

J. Coordinate bus-assembly terminations to equipment enclosures to ensure proper phasing, connection, and closure.

330.040 EARTHING

A. Provide electrical bonding and equipment earthing connections for busways as indicated and specified in Division Y Section "Earthing and Bonding".

B. Tighten bonding and earthing connections to comply with tightening torques specified in applicable Standard or to assure permanent and effective earthing.

330.050 FIELD QUALITY CONTROL

A. Test busway runs prior to energizing as follows and provide written report of tests.

1. Phasing: verify that proper phase relationships exist between source, busway, and connected equipment using phase rotation meter and verifying phase continuity from source to equipment.
2. Insulation Resistance: measure IR for all busway components with 1000 Volt d.c. megohmmeter and compare in report with manufacturer's stated acceptable values. Measure each phase to phase and each phase to earth. Any reading should be better than 100 megohm.

B. Energize busway and demonstrate functioning in accordance with requirements.

C. Test Failures: Correct deficiencies identified by tests and make ready for retest. Verify that equipment meets the specified requirements.

330.060 CLEANING AND FINISH REPAIR

A. Upon completion of installation of busways, remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches and abrasions.

B. Galvanized Finish: repair damage using a zinc-rich paint recommended by the manufacturer.

C. Paint Finish: repair damage using matching touch-up coating recommended by the manufacturer.

330.070 ADJUSTMENT

A. Align busway runs vertically and horizontally to eliminate sags and twists. Provide support stiffeners at locations where indicated and where there is excessive movement.

B. Check bus plug circuit breaker trip settings against connected loads and revise as required to conform to recommended values.

330.080 PROTECTION

A. Provide final protection to ensure that moisture does not enter bus assembly.

330.090 DEMONSTRATION

A. Train Employer's maintenance personnel to adjust, operate, and maintain the system installation. Refer to Division A Section "Demonstration and Training and Closeout Procedures."

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SECTION Y64 - CABLE TRAYS FOR ELECTRICAL SYSTEMS

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. This Section includes cable trays, cable ladders and related installations and accessories necessary to support and protect cables, feeders, sub-feeders, branch circuit wiring and wiring of low current systems, communications and signal cables. Supporting accessories shall include but not limited to necessary carriage bolts with nut below head, roofing bolts with nut, channel withstanding threaded rod, wall bracket, uni-strut, fish plate, washers, etc.

110.000 DESIGN PARAMETERS

110.010 PROJECT/SITE CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by the Employer or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify Engineer not less than 2 days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Engineer's written permission.

110.020 REFERENCE STANDARDS

A. Comply with the following standards:

1. IEC 61537.
2. ISO 1461.
3. ISO 12944-2.

120.000 SYSTEM DESCRIPTION

120.010 CABLE TRAYS AND LADDERS

A. Cable trays and ladders shall comply with IEC 61537.

B. Cable trays shall meet Class C requirements for perforation free area as per IEC 61537 as a minimum.

C. Cable ladders shall meet Class Y requirements for free base area as per IEC 61537 as a minimum.

D. Components: To include cable trays or ladders (as shown on the Drawings), bends, elbows, tees, couplings and plates, rubber grommets, hangers, bracket supports and other system accessories required for safety and protection of the cable installations. All fittings and accessories shall be purpose made from the manufacturer. Field fabricated fittings and accessories are not acceptable.

E. Trays: Provide to carry the maximum load of cables with a factor of safety 300% or 90 kg concentrated load whichever is more stringent.

F. Trays: Heavy gauge perforated sheet steel, heavy duty, hot-dip galvanized after manufacture, minimum 1.5 mm thickness for cable trays up to 300 mm width and 2 mm thickness for cable trays exceeding 300 mm width, with sides not less than 60 mm depth for cable trays up to 300 mm width, 85 mm depth for cable trays exceeding 300 mm width and up to 600 mm width and 110 mm depth for cable trays exceeding 600 mm width with outwards return flanges, unless otherwise recommended by manufacturer and approved by the Engineer. Fittings shall be made of the same material as tray. Covers, where shown on the Drawings, shall be minimum 1.0 mm thick for cable trays up to 600 mm width and 1.5 mm thick for cable trays exceeding 600 mm width and shall be

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made of sheet steel hot-dip galvanized after manufacture, snap-on or bolt type, forming a rigid assembly with the tray.

G. Trays Perforation: Cable trays perforation size and direction shall be properly designed to suit cable ties or cleats to be used for cable fixation. Contractor shall submit method of cable fixation for Engineer's approval prior to installation.

H. Ladders: Hot-dip galvanized after manufacture, fabricated from 2 mm mild carbon steel. Ladder side channels shall be minimum 125 x 22 mm, strengthened by reinforcing inserts for torsional rigidity. Rungs shall be slotted to take cable cleats or ties and conduit clamps. Rungs shall be minimum 50 x 25 mm channels, spaced at 300 mm centers.

I. Fully controlled, stringent pretreatment process including, alkaline de-greasing, rinsing, pickling, fluxing and drying shall be carried out before hot dip galvanizing.

J. Galvanizing shall be in accordance with ISO 1461, applied after fabrication with local coat thickness of 45 µm (local coating mass of 325 g/m2) and mean coat thickness of 55 µm (mean coating mass of 395 g/m2).

K. Cable trays / ladders installed in corrosive atmosphere shall be provided with powder coating over hot dip galvanization of high chemical resistant polyster / epoxy to meet the requirements of the below classification. High bonding between the galvanizing and the paint finish shall be certified by the manufacturer with a guaranteed life of 20 years.

1. For installations in outdoor industrial areas and coastal areas with moderate salinity and indoor in swimming pools, chemical plants, coastal ship and boatyards; use galvanization and powder coating in compliance with corrosion risk category C4 to ISO 12944-2.
2. For installations in outdoor industrial areas with high humidity and aggressive atmosphere and in indoor areas with almost permanent condensation and with high pollution; use galvanization and powder coating in compliance with corrosion risk category C5-I to ISO 12944-2.

L. Bolts and Screws: Cadmium plated or electrolytically galvanized.

M. Sizes: Trays and ladders shall be standard metric sizes, 150, 300, 450, 600 and 900 mm wide, and at least 3 m length of section. Size of tray or ladder shall be determined by number and sizes of cables in accordance with the Regulations and / or as shown on the Drawings. Tray or ladder shall have strength and rigidity to provide support for cables contained within. Deflection between supports shall comply with IEC 61537 requirements.

N. Earthing connector for trays or ladders shall be provided on each coupling between adjacent sections.

O. Products shall be provided with stamped markings by manufacturers.

P. Cable trays and ladders shall be provided with galvanized ventilated sunshade covers when installed in outdoor locations. Sun shade and fixings shall be from the same manufacturer of cable tray/ladder.

Q. Finish of the cable trays/ladders used outdoors shall be certified to be UV stabilized.

120.020 WIRE-BASKET CABLE TRAYS

A. Description:

1. Configuration:

a) Wires are formed into a standard (50-by-100-mm) wire mesh pattern with intersecting wires welded together. Mesh sections must have at least one bottom longitudinal wire along entire length of section.
b) Utilize the appropriate under floor or overhead basket-type cable tray components and fittings when applicable.

B. Materials: High-strength-steel longitudinal wires with no bends.

C. Safety Provisions:

1. Wire ends along wire-basket sides (flanges) rounded during manufacturing to maintain integrity of cables and installer safety.

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2. The cable tray system shall include all continuous grounding hardware components.
3. Consider exposure rating of cable tray components for all installation environments including air handling (plenum) spaces, extreme, harsh, indoor or outdoor areas.

D. Sizes:

1. Straight sections shall be furnished in standard 3000-mm lengths.
2. Select cable tray width and depth parameters to maintain a final fill capacity of no greater than fill capacity stated Division W Sections.
3. Available dimensions:

a) Wire-Basket Depth: 25-mm usable loading depth by 100 mm and 300 mm wide.
b) Wire-Basket Depth: 50-mm usable loading depth by 100 mm,150 mm,200 mm,300 mm,450 mm and 600 mm wide.
c) Wire-Basket Depth: 100-mm usable loading depth by 200 mm,300 mm,450 mm and 600 mm wide.
d) Wire-Basket Depth: 150-mm usable loading depth by 200 mm,300 mm,450 mm and600 mm wide.

E. Connector Assemblies: Bolt welded to plate shaped to fit around adjoining tray wires and mating plate. Mechanically joins adjacent tray wires to splice sections together or to create horizontal fittings.

F. Connector Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.

G. Hardware and Fasteners: A full complement of fittings for the cable tray shall be available including, but not limited to 45 and 90 degree flat elbows, vertical inside and outside elbows, tee fittings, couplings for joining sections of the tray, hangers, end blanks, and all other components necessary to make the system workable. The fittings and accessories shall be of compatible material and color.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

1. Drawings and general provisions of the Contract, including Conditions of Contract and Division 01 Specification Sections, apply to this Section.

210.000 RELATED SECTIONS

1. Division P Section "Fire Stopping Systems" for fire stopping materials and installation requirements.
2. Division V Section "Basic Electrical Materials and Methods" for cable tray / ladder supports not specified in this Section.

PART 3 PRODUCTS AND WORKMANSHIP

300.000 MATERIALS

300.010 MANUFACTURERS

A. Approved Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

1. B-Line Systems, Inc.
2. Thomas & Betts
3. Swifts
4. Wibe

B. Locally manufactured cable trays / ladders are acceptable subject to compliance with design requirements.

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300.020 PRODUCTS

A. Products: Subject to compliance with requirements, provide one of the products indicated for each designation as shown on plans.

310.000 QUALITY MANAGEMENT

310.010 QUALITY ASSURANCE

A. Source Limitations: Obtain cable trays and components through one source from a single manufacturer.

310.020 DELIVERY, STORAGE AND HANDLING

A. Materials shall not be stored in damp and open environment and shall be stored in covered places only.

310.030 COORDINATION

A. Coordinate layout and installation of cable tray / ladder with other installations to ensure clear access to the cable trays to facilitate maintenance, checking and further pulling of cables.

   1. Revise locations and elevations from those indicated as required to suit field conditions and as approved by the Engineer.

320.000 SUBMITTALS

A. Technical Data: Submit data for approval including, but not limited to, the following:

   1. Manufacturers' catalogues with specifications of cable trays / ladders and related accessories.
   2. Samples of each type of tray / ladder and accessory.

B. Shop and Construction Drawings: Submit drawings for approval including, but not limited to, the following:

   1. Detail fabrication and installation of cable tray / ladder, including plans, elevations, and sections of components and attachments to other construction elements. Designate components and accessories, including clamps, brackets, hanger rods, splice-plate connectors, expansion-joint assemblies, straight lengths, fittings and earthing connections.

C. Point-wise compliance statement to the specifications, duly signed by the manufacturer/ manufacturer’s authorized representative and the contractor.

D. Approved Third Party Test Certificates: Submit to verify compliance with the IEC 61537, as applicable.

E. Coordination Drawings: Include floor plans and sections drawn to scale. Include scaled cable tray / ladder layout and relationships between components and adjacent structural and mechanical elements.

F. Design Calculations: Submit design calculations to verify the following:

   1. Loading capacities for supports.
   2. Perforation base area for cable trays according to the specified Class.
   3. Free base area for cable ladders according to the specified Class.

G. Factory Test: Submit Factory tests including safe working load, deflection tests and measurement of steel and galvanization thicknesses.

H. Maintenance Data: For cable trays to be included in the maintenance manuals specified in Division 01.

I. As-Built (Record) Drawings: At Project close-out, submit Record Drawings of installed cable trays in accordance with requirements of the Specification, Division 01.

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330.000 EXECUTION

330.010 INSTALLATION

A. Install cable tray / ladder level and supporting system according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards.

B. Spare capacity shall be 25 % for vertical installations and 15% for horizontal installations.

C. Each run shall be completed before installation of cables. Submit calculations taking into consideration the maximum cables load on cable trays with a factor of safety 300%.

D. Remove burrs and sharp edges from cable trays / ladders. Fix trays / ladders using approved suspension rods or uni-struts or angle brackets at spacing not exceeding 1.5 m and as per the approved supports calculations.

E. Cables Fixation: Secure cables to tray / ladder with purpose made straps, cleats or saddles as specified in Division Y Section "Low Voltage Electrical Power Conductors and Cables" and Division Y Section "Medium Voltage Cables". Cable cleats and ties shall be correctly sized and tightened to secure the cable without indenting the insulation sheath.

F. Cables Arrangement: Arrange cables in one layer only, with minimum spacing of one diameter of the larger of the two adjacent cables or of a trefoil formation of single core cable circuit, unless otherwise shown on the Drawings.

G. Cables Bending Radius: Cables installation on trays / ladders shall ensure that the minimum cable bending radius as recommended by the manufacturer is not violated.

H. Fasten cable tray / ladder supports securely to building structure as specified in Division V Section "Basic Electrical Materials and Methods," unless otherwise indicated.

   1. Design supports, including fastenings to the structure, to carry the total load of cables and trays multiplied by a safety factor of 3. Submit calculations for approval.

I. Cables Installation on Trays / Ladders: Use necessary rollers and pulleys at proper spacing for installation of large and long run cables. Pulleys / rollers shall be fixed to structural elements and not cable trays / ladders. Necessary pulling tools such as basket grips or pulling eyes shall be used with a proper force and speed to ensure not exceeding the manufacturer’s recommended maximum cable pulling tension.

J. Make connections to equipment with flanged fittings fastened to cable tray / ladder and to equipment. Support cable tray / ladder independently of fittings. Do not carry weight of cable tray / ladder on equipment enclosure.

K. Install expansion connectors where cable tray / ladder crosses a building expansion joint and in cable tray / ladder runs that exceed 39 m, unless otherwise calculated by the manufacturer and approved by the Engineer considering a maximum movement of 25 mm.

L. Make cable tray / ladder connections, changes in direction and elevation using standard fittings. Fittings shall be properly curved / designed to satisfy the minimum bending radius requirements and avoid sharp edges / corners.

M. Locate cable tray / ladder above piping, unless accessibility to cable tray / ladder is required or unless otherwise indicated.

N. Seal penetrations through fire zones or smoke barriers as specified in Division P Section "Fire Stopping Systems."

O. If cable trays / ladders are sized for future cables, furnish necessary provisions for penetrations with capped sleeves for future cables through fire-rated partitions, or use "repairable" fire stopping-penetration sealing material.

P. Workspace: Install cable trays / ladders with sufficient space to permit access for installing cables. Minimum clearance of 250 mm shall be maintained between top of tray / ladder and ceiling, beams and other services and between tray / ladders in multi-tier formation.

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Q. Tray / ladders shall not carry conductors of different systems, such as power, communications and data processing, or different insulation levels, such as 600V, 5000V, and 20,000 V. Branch circuit cables can run on cable trays / ladders where there is sufficient space above false ceiling.

R. Install covers after installation of cable is completed.

S. Labeling of trays shall be provided at every change in direction and at every 12 meters on straight runs. Size of letters and color of labels, marking and references shall be as per the relevant standard regulations.

T. Cable trays/ladders shall not be installed in lengths below water/sewage pipes.

U. Electrical continuity strips / links shall be provided by the manufacturer of the tray/ladder.

330.020 CONNECTIONS

A. Ground cable trays / ladders according to manufacturer's instructions.

1. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values.

330.030 WARNING SIGNS

A. After installation of cable trays / ladders is completed, install warning signs in visible locations on or near cable trays / ladders.

330.040 FIELD QUALITY CONTROL

A. Perform the following tests and inspections in coordination with the contractor as proper and applicable:

1. Visually inspect cable insulation for damage. Correct sharp corners, protrusions in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
2. Verify that the number, size, and voltage of cables in cable trays meet specification and the approved Shop Drawings requirements. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
3. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
4. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
5. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and re-torque in suspect areas.
6. Verify that no corroded units are present.
7. Check for improperly sized or installed bonding jumpers.
8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Grounding: Do not use metal trays / ladders as earth continuity conductor. Connect trays / ladders by flexible tinned copper straps to nearest bare earthing conductor and at maximum 30-m spacing.

C. Anchorage: Test pullout resistance for toggle bolts and powder-driven threaded studs for each type and size of anchorage material.

1. Furnish equipment, including jacks, jigs, fixtures, and calibrated indicating scales, required for reliable testing.
2. Obtain Engineer's approval before transmitting loads to the structure. Test to 90 percent of rated proof load for fastener.

D. Replace malfunctioning units and retest until satisfactory results are achieved.

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E. Prepare test and inspection method for Engineer's approval. Submit test reports after completion on site.

330.050 CLEANING

A. On completion of cable tray / ladder installation, including fittings, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes, including chips, scratches, and abrasions.

330.060 PROTECTION

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure cable tray / ladder is without damage or deterioration at the time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray / ladder manufacturer.
2. Repair damage to PVC or paint finishes with matching touchup coating recommended by cable tray / ladder manufacturer.

END OF SECTION Y64

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Y65 - UNDERFLOOR RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. Description of Work: Raceways including wireways and related installations and accessories necessary to support and protect feeders, branch circuit wiring and wiring of low current systems, communications and signal cables.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Standards:

1. Comply with related BS Standards.

120.000 SYSTEM DESCRIPTION

120.010 UNDERFLOOR TRUNKING

A. Type: For installation in floor screed, laid on unfinished concrete floor, secured and grouted flush with screed.

B. Material: 3.3 m lengths of 2 mm thick (14 gauge) galvanized sheet steel, protected by corrosion resistant coating on inside and outside surfaces. Single, double or triple systems, as required, are to be as shown on the Drawings. Dimensions are to be as indicated.

C. Openings: Ducts are to have 32 mm openings spaced at 600 mm with screw plugs for receiving initial or future installation of outlet boxes. Screw plugs are to be replaced by brass ferrules, inserted and securely fastened by crimping tool, for installation of pedestal type outlet boxes.

D. Fittings: Ducts are to be supplied with approved standard manufacturer's fittings, couplings, adjustable duct supports, duct to conduit adapters, horizontal 45 and 90 degree bends, vertical 90 degree bends, terminal bushings to cabinets, cross-unders, offsets, plugs, ferrules and complete set of tools for installation and maintenance after installation.

E. Junction Boxes: Flush, cast iron, or galvanized sheet steel or die-cast metal protected by corrosion resistant coating and suitable for double or triple duct systems, as required, and shown on the Drawings. Openings are to be provided for ducts and conduits. Interior of boxes is to be partitioned for two or three services; completely isolating each duct system and providing straight cross-junctions. Leveling and anchoring of boxes is to be by adjusting screws at four corners. Flush cover plates are to form smooth surface with flooring.

F. Flush Outlet Boxes: Factory designed, with accessories necessary to accommodate specific outlets shown on the Drawings or cable outlets as required for signal or control services, with cord-grip nipples.

G. Supports are to be capable of adjustment for height and arranged for maintenance of alignment and spacing of raceways during concreting.

H. Recessed Service Fittings: Modular fittings that match with preset inserts and include covers/ receptacles, outlets and associated device plates to provide service indicated at each location. Covers are to be flush with floor and have a recess to match floor finish and level with the area. Boxes' covers are to be firmly held in place and non-rocking. Coordinate with architectural designs and materials approved for finishes and for electrical devices. Internally mounted receptacle / outlets are to be as shown on drawings.

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PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and Division A Specification Sections, apply to this Section.

210.000 RELATED SECTIONS

A. Related Sections include the following:

1. Division H and E Sections related to Precast Concrete-Plant Cast for precast concrete units used as cellular concrete floor raceway.
2. Division G Section " Metal Profiled Sheet Decking " for cellular metal floor raceway.
3. Division Z Section "Preservative And Fire Retardant Treatment" for fireproofing cellular metal floor raceway.
4. Division V Section "Basic Electrical Materials and Methods".
5. Division V Section "Wiring Devices" for receptacles installed in service fittings.

PART 3 PRODUCTS AND WORKMANSHIP

300.000 MATERIALS

300.010 MANUFACTURERS

A. Approved Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

1. Dietzel-Univolt
2. EGA Tube/M.K./Honeywell
3. Schneider Electric
4. Schneider Electric / Square D Co.
5. Thomas & Betts Corp.
6. Wiremold/Legrand
7. Wirenold/Legrand Walker
8. Ackerman

310.000 QUALITY MANAGEMENT

310.010 QUALITY ASSURANCE

A. Source Limitations: Obtain underfloor raceway components through one source from a single manufacturer.

320.000 SUBMITTALS

A. Technical Data: Submit data for approval including, but not limited to, the following:

1. Manufacturers' catalogues with specifications of raceways and related accessories.
2. Samples of each type of raceway and accessory.

3. Samples: Service fittings and flush outlet covers with required finish, for approval.

B. Shop and Construction Drawings: Submit drawings for approval including, but not limited to, the following:

1. Exact routing with indication of boxes, accessories and expansion joints, size and type of boxes.
2. Typical assembly details of installation etc.

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3. Construction details of pull boxes.
4. Typical installation details including connection enclosure, connection of flexible conduits, and earthing connections.
5. For prewired installations, submit drawings for approval showing the complete layout of all products that make up the complete system for each floor prior to the installation of raceway with the lengths, device type (power and data), locations and circuits identified.

C. Coordination Drawings: Include floor plans and sections drawn to scale. Identify components and accessories such as expansion-joint assemblies, straight raceway lengths, inserts, outlets, and fittings. Show underfloor raceway layout, connections between raceway elements, and relationships between components and adjacent structural elements.

D. Record (As-Built) Documents: Show dimensioned locations of underfloor raceways, junction boxes, and preset and after-set inserts. Include locations, types, and circuiting of service-outlet fittings.

E. Maintenance Data: For underfloor raceways to include in maintenance manuals specified in Division A.

1. Include detailed manufacturer's written instructions on locating preset inserts and on installing after-set inserts.

330.000 EXECUTION

330.010 COORDINATION

A. Coordinate layout and installation of underfloor raceway products with structural work, including slab reinforcement, and with floor finish work.

1. Coordinate height of preset inserts, junction boxes, access units, and raceways with depth of concrete slab and floor fill.
2. Coordinate thickening of slabs where required for adequate encasement of raceway components.
3. Coordinate exposed components with floor-covering materials to ensure fittings and trim are suitable for floor-covering material furnished.
4. Revise locations from those indicated as required to suit field conditions and ensure functioning layout, and as approved by Engineer.

330.020 EXAMINATION

A. Examine substrate for compliance with requirements for installation tolerances and other conditions affecting performance of underfloor raceways. Do not proceed with installation until unsatisfactory conditions have been corrected.

330.030 INSTALLATION

A. Install underfloor raceways as indicated on the Drawings, in compliance with the Specification and according to manufacturer's written instructions.

B. Install raceways aligned and leveled and, unless otherwise indicated, parallel or perpendicular to building walls.

C. Arrange supports to attain proper elevation, alignment, and spacing of raceways. Install supports securely at ends and at intervals not to exceed 1500 mm to prevent movement during concrete pour.

D. Seal raceways, cells, and inserts to prevent water, concrete, or foreign matter from entering raceways before and during pouring slab or placing fill. Provide tape or sealing compound at joints as recommended by raceway manufacturer.

E. Remove burrs, sharp edges, dents, and mechanical defects.

F. Cap or plug boxes, openings, and open raceway ends.

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G. Junction Boxes: Install tops level and flush with finished floor. Install blank closure plates or plugs to close unused junction-box openings. Install boxes in place with grout to prevent movement during construction. Install supports, couplings and locking and grounding devices with screws tightened in accordance with raceway manufacturer's torquing values. Remove burs, which may cause damage to insulation. Place top covers in inverted position to prevent damage to surface of cover.

H. Install devices and service fittings at points of use indicated.

1. Cut; hole saw, and drill slab and raceways to allow wiring installation.

I. Install markers at each cell to identify service. Install markers flush at screed line before pouring slab or placing fill. Extend marker with grommeted screw when floor covering is placed. Do not extend through carpet. Install markers at inserts adjacent to junction boxes, on both sides of permanent walls, and at end of each raceway run. Use slotted-head screw to identify electrical power and Phillips-head screw to identify telephone.

330.040 CONNECTIONS

A. Ground underfloor raceways and components.

1. Tighten connectors and terminals according to manufacturer's published torque-tightening values.

330.050 CLEANING

A. After installation, clean underfloor raceways, including outlet fittings and devices, and inspect exposed finish.

330.060 ADJUSTING

A. Level raceway components with finished slab and make adjustments for floor finishes.

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Y66 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. This Section includes underground conduits and ducts, duct banks, pull boxes and handholes, manholes, and other underground utility structures.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Comply with specified Standards.

110.020 PROJECT/SITE CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Employer or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify Engineer not less than 2 days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Engineer's written permission.

120.000 SYSTEM DESCRIPTION

120.010 GENERAL SYSTEM DESCRIPTION

A. Underground Ducts for Electrical Utility Service: UPVC encased in concrete.

B. Underground Ducts for Electrical Feeders: Direct-buried UPVC conduit.

C. Underground Ducts for Electrical Branch Circuits: UPVC conduit encased in concrete.

D. Underground Ducts for Telephone Utility Service: UPVC utility duct encased in concrete.

E. Underground Ducts for Communication Circuits: UPVC underground conduit encased in concrete.

F. Manholes: Underground, precast concrete utility structures.

G. Manholes: Cast-in-place concrete.

120.020 UNPLASTICIZED POLYVINYL CHLORIDE (UPVC) DUCTS

A. UPVC Ducts for Outdoor Power and Lighting Cable Installations: Non-sparking type, suitable for direct burial in ground, Class B to BS 3506, supplied in standard 6 m lengths, with one end of each length tapered.

1. Nominal Size: As shown on Drawings.
2. Minimum Wall Thickness: 3.4 mm for 100-mm ducts; 4.5 mm for 150-mm ducts.

B. Duct Supports: Rigid UPVC spacers selected to provide minimum duct spacings and concrete cover depths indicated, while supporting ducts during concreting.

C. Duct Sealing Compound: Non-hardening, safe for human skin contact, not deleterious to cable insulation, and workable at temperatures as low as 1 deg. C. Capable of withstanding temperature of 149 deg. C without slump and of adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

120.030 COVERS FOR MANHOLES AND HANDHOLES

A. Frames and Covers: EN 124, checkered cast iron or cast steel, recessed type, and of suitable duty for the particular application. Machine cover-to-frame bearing surfaces

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1. Covers: Cast-in legend "ELECTRIC" or "TELEPHONE" as appropriate..

120.040 COMPOSITE CONSTRUCTION

A. Concrete: Comply with Division 03 Section "Cast-in-Place Concrete" for concrete and reinforcement.

B. Concrete Envelope: For duct banks for power distribution systems and outdoor lighting cable installations crossing water, gas and sewage mains, under roadways and where required or shown on the Drawings, is to be 21 MPa, 28-day, compressive-strength reinforced concrete using sulfate-resisting Portland cement. Reinforcement is to consist of 12-mm diameter longitudinal bars at approximately 300-mm centers along bottom and sides of duct bank with 10-mm diameter U-shaped transversal bars at 400-mm centers. Extend concrete envelope at least 300 mm beyond each side of crossing, etc.

C. Cable Manholes and Handholes: 21 MPa, 28-day, compressive strength reinforced concrete using sulfate-resisting Portland cement, with approved waterproof membrane on external surfaces, and with cable supports where necessary, pull-eyes, and drain pit and drain pipe as required. Dimensions and reinforcement are to be as shown on the Drawings or in accordance with approved standard details shown on shop and construction drawings.

120.050 PULL BOXES

A. Cast-Metal Boxes: Cast aluminum, sized as indicated, with outside flanges and recessed, gasketed cover for flush mounting. Nonskid finish on cover.

B. Fiberglass Boxes: Molded fiberglass, sized as indicated, with 150-mm square cable entrance at each side and weatherproof cover with nonskid finish.

C. Cover Legend: "ELECTRIC."

120.060 UNDERGROUND, PRECAST CONCRETE UTILITY STRUCTURES

A. Precast Units: Interlocking, mating sections, complete with accessory items, hardware, and features as indicated. Include concrete knockout panels for conduit entrance and sleeve for ground rod.

B. Design structure according to details on Drawings.

C. Structural Design Loading: Heavy traffic.

D. Covers: Recess on cover accepts finish material in landscaped and paved areas.

E. Joint Sealant: Continuous extrusion of asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground water level at grade.

120.070 CONSTRUCTION MATERIALS

A. Waterproofing: Comply with Division J Section " Waterproofing."

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and Division A Specification Sections, apply to this Section.

210.000 RELATED SECTIONS

A. Division D Section "Excavating and Filling" for excavation, backfill, and related items for ducts, manholes, and handholes.

B. Division E Section " Accessories Cast Into In Situ Concrete " for concrete requirements.

C. Division J Section " Waterproofing".

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D. Division V Section "Basic Electrical Materials and Methods".

E. Division Y Section "Earthing and Bonding" for ground rods at manholes.

PART 3 PRODUCTS AND WORKMANSHIP

300.000 MATERIALS

300.010 PRODUCTS

A. Products: Subject to compliance with requirements, provide one of the products indicated for each designation as shown on plans.

310.000 QUALITY MANAGEMENT

310.010 QUALITY ASSURANCE

A. Comply with specified Standards.

310.020 DELIVERY, STORAGE AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete units at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

310.030 COORDINATION

A. Coordinate layout and installation of ducts, manholes, and handholes with final arrangement of other utilities as determined in the field.

B. Coordinate elevations of duct and duct-bank entrances into manholes and handholes with final profiles of conduits as determined by coordination with other utilities and underground obstructions. Revise locations and elevations from those indicated as required to suit field conditions and to ensure duct runs drain to manholes and handholes, and as approved by Engineer.

320.000 SUBMITTALS

A. Product Data: For metal accessories for manholes and handholes, conduits and ducts, duct-bank materials, and miscellaneous components.

B. Shop Drawings: Show details and design calculations for precast manholes and handholes, including reinforcing steel. Include Shop Drawings prepared by registered professional structural engineer, as indicated by seal on Shop Drawings.

C. Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures. Include plans and sections drawn to scale.

D. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

E. Record (as-Built) Documents: Show dimensioned locations of underground ducts, handholes, and manholes.

330.000 EXECUTION

330.010 EXAMINATION

A. Examine substrates, areas, and conditions to receive ducts and utility structures for compliance with requirements for installation tolerances and other conditions affecting performance of underground ducts and utility structures. Do not proceed with installation until unsatisfactory conditions have been corrected.

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330.020 EARTHWORK

A. Excavation and Backfill: Comply with Division D Section "Excavating And Filling " but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Trenches: Width is to be as small as practicable with sides vertical. Remove mud, rock projections, boulders and hard spots from trench bottom and trim level. Inform the Engineer in advance to give him reasonable opportunity to inspect trench for each section of the work.

C. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

D. Restore all areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Perform according to Division Q Section " Landscape Maintenance."

E. Restore Disturbed Pavement. Refer to Division A Section "Cutting and Patching."

330.030 DIRECTLY BURIED UPVC CABLE DUCTS

A. Lay and join ducts to required line and level on sand bed, cover with sand and backfill trench to ground level with excavated soil, free from stones and other debris, well compacted in layers not exceeding 300 mm thick.

B. Lay approved concrete tiles to fully cover cable duct, extending minimum 50 mm beyond sides of duct and placed 300 mm below ground level.

C. Provide warning tape or galvanized steel mesh along duct runs at a depth 200 mm below ground level.

330.040 UNDERGROUND CABLE DUCT ASSEMBLIES

A. Install duct as indicated, according to manufacturer's written instructions.

B. Form duct assembly to required line and level, using duct supports spaced to prevent sagging of ducts and breaking of couplings and watertight seals, and secured with cords (not tie wires) where necessary.

C. Slope: Pitch ducts a minimum of 1:300 (preferably 1% slope) to drain toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between 2 manholes to drain in both directions.

D. Join ducts using waterproof cement, to manufacturer's recommendations, to give waterproof and sand-proof joint with at least 80 mm overlap.

E. Provide 3 mm galvanized steel wire inside empty ducts, for future pulling of cables, extending 1 m beyond duct banks at both ends and securely fixed to wooden bungs sealing the duct.

F. Concrete-Encased Ducts: Support on plastic separators coordinated with duct size and required duct spacing, and install according to the following:

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, and secure separators to the earth and to ducts to prevent floating during concreting. Do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
2. Concreting: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not use power-driven agitating equipment unless specifically designed for duct-bank application. Pour each run of envelope between manholes or other terminations in one continuous operation. When more than 1 pour is necessary, terminate each pour in a vertical plane and install 19-mm reinforcing rod dowels extending 450 mm into the concrete on both sides of joint near the corners of the envelope.
3. Reinforcement: Reinforce duct banks where they cross disturbed-earth and where indicated.
4. Forms: Use the walls of the trench to form the side walls of the duct bank where the soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
5. Minimum Clearances between Ducts: 75 mm between ducts and exterior envelope wall, 50 mm between ducts for like services, and 100 mm between power and signal ducts.

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G. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs.

330.050 ENDS OF DUCTS

A. Ducts ending in cable manholes or handholes are to be neatly cut and reamed and set behind chamfered precast concrete duct end blocks or terminated with appropriate bell-mouth bushing set in concrete wall. Ducts not ending in cable manholes or handholes are to be properly capped.

B. Sealing Ends Of Ducts: Completely seal conduits and ducts, active or spare, at entry into buildings or manholes, with approved plastic moulds or wooden bungs to prevent entry of rodents, gas and vapor.

330.060 SLEEVES OR DUCTS IN EQUIPMENT FOUNDATIONS

A. Provide sleeves or ducts in equipment foundations, whether or not shown on Drawings, in accordance with approved shop and construction drawings or as instructed by the Engineer. Obtain approval of sleeve or duct installation prior to pouring concrete.

330.070 UNDERGROUND UTILITY STRUCTURE INSTALLATION

A. Drainage: Install drains in bottom of units. Coordinate with drainage provisions indicated.

B. Waterproofing: Apply waterproofing to exterior surfaces of units after concrete has cured at least 3 days. Apply according to Division J Section ‘’Waterproofing’’. After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole and handhole chimneys after brick mortar has cured at least 3 days.

C. Cast-in-Place, Underground Structure Installation: Comply with applicable requirements of Division E Section " Accessories Cast Into In Situ Concrete."

1. Finish interior surfaces with a smooth troweled finish.

D. Precast Concrete, Underground Structure Installation: Install as indicated, according to manufacturer's written instructions.

1. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
2. Support units on a level bed of crushed stone or gravel, graded from the 25-mm sieve to the 4.75-mm sieve and compacted to the same density as adjacent undisturbed earth.

330.080 FIELD QUALITY CONTROL

A. Inspection of Duct Systems: Inspect directly buried ducts and underground duct assemblies in the presence of the Engineer, before backfilling or concreting. Steel mandrel or other approved device, diameter equal to 90% of inside diameter of duct and 500 mm long, is to be pulled through entire run of duct and is to pass through without getting stuck. Ducts, which do not allow mandrel to be pulled through, are to be repaired or replaced to the satisfaction of the Engineer.

B. Testing: Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.

C. Correct installations where possible and retest to demonstrate compliance. Remove and replace defective products and retest.

330.090 CLEANING

A. Clean ducts with stiff bristle brush pulled through each duct prior to pulling in cables. Pull brush through full length of ducts. Use round-bristle brush with a diameter 12 mm larger than the ID of duct.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

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Y71A - SWITCHBOARDS

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. This Section includes Main Distribution Board(s) work for low voltage (LV) distribution, ancillary mounting frames, fittings, cable termination accessories and supports.

B. Connection to BMS system, including interface elements such as relays, transducers, etc. as detailed in Division W Specification Sections BMS schedules and /or shown on the Drawings.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Codes and Standards: Comply with the latest issue of:

1. IEC 61439-1 & IEC 61439-2: Low Voltage Switchgear and Control Gear Assemblies.
2. IEC 60947-1: Low Voltage Switchgear and Control Gear: Part 1: General Rules.
3. IEC 60947-2: Low Voltage Switchgear and Control Gear: Part 2: Circuit Breakers.
4. Relevant IEC Standard for other components, where not otherwise specified.

110.020 PROJECT/SITE CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving main distribution boards into place.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Employer or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Engineer not less than seven days in advance of proposed utility interruptions. Identify extent and duration of utility interruptions.
2. Indicate method of providing temporary utilities.

C. Environmental Limitations: Rate equipment for continuous operation under the following, unless otherwise indicated:

1. Ambient Temperature: Not exceeding 40 deg C.
2. Altitude: Not exceeding 2000 m.

100.020 DEFINITIONS AND ABBREVIATIONS

D. MDB: Main distribution board.

E. CT: Current Transformer.

F. VT: Voltage Transformer.

G. EMI: Electromagnetic interference.

H. RMS: Root mean square.

I. The following terms used on the Drawings and in the Specification are synonymous and may be used interchangeably: "Switchboard" and "Main Distribution Board".

120.000 SYSTEM DESCRIPTION

120.010 GENERAL REQUIREMENTS

A. Generally: Main distribution boards shall be dead-front type, metal enclosed, multi-cubicle, floor mounted, free standing, with 1000V rated insulation voltage, 600 V rated operational voltage, and with 12 kV impulse withstand voltage, with fixed or draw-out switchgear, manually or manually

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and electrically operated, as shown on the Drawings, with matching vertical sections to form a continuous integral and rigid structure. Outgoing sections shall be of equal width.

A. Generally: Coordinate with Building Management System (BMS) supplier and provide all necessary interfaces, relays, transducers, etc, necessary for the functions specified in the BMS schedules and/or shown on the Drawings.

B. General Construction: Rigidly framed and bolted, with Electro-galvanized sheet steel enclosures, phosphatized, primed with rust inhibiting primer and finished with thermal polymerized polyester epoxy powder coating, gray colour (RAL 7035 ANSI 61) or standard manufacturer's colour subject to Engineer's approval. Switchgear shall be vermin, dust and rodent proof, IP 31 protection to IEC 60529 for indoor installations and IP 54 protection for installations in wet areas and IP55 degree of protection for outdoor installations, with adequate lifting means and base-frames and capable of being moved into position and directly bolted to floor without additional sills. For ratings up to 3200A, enclosures shall have mechanical impact resistance of IK10 to IEC 62262 for enclosures protection degree IP 54 and higher, and IK08 to IEC 62262 for enclosures protection degree lower than IP 54. Test certificates for mechanical impact shall be submitted for approval; otherwise enclosure thickness shall not be less than 1.5mm. For rating larger than 3200A, enclosures shall have minimum thickness of 2mm.

C. Ventilation: Compartments shall be ventilated, by approved methods complying with the Standards.

D. Main Distribution Boards shall have a short circuit withstand current of the rating shown on the Drawings for 1 sec.

E. Fastenings between structural members shall be bolted.

F. Extension of structure and busbars shall be possible at either end of switchboard for form 3 and form 4 type switchboards.

G. Arrangement shall permit incoming and outgoing busbars and cables to enter enclosure as indicated on the Drawings and connect at respective terminals without inconvenience to installation or maintenance.

H. Removing Circuit Breakers: Suitable arrangements and equipment shall be provided for extracting, lifting and unloading switchgear from enclosures as appropriate for type of switchgear.

I. Spare and space positions are defined as follows:

    1. Spare position: Fully equipped enclosure with switchgear
    2. Space position: Fully equipped enclosure ready to receive switchgear.

J. Busbars: Site rated to same rating of main circuit breaker frame size as a minimum unless otherwise shown on drawings, and braced for a symmetrical rms short-circuit duty as specified. Busbars shall be copper, of sufficient size to limit temperature rise to allowable equipment temperature ratings, and not exceeding IEC 61439-1&-2 limits. Connections and buswork shall be bolted with compatible hardware material as per manufacturer's recommendations and shall be accessible for inspection and maintenance. Contact surfaces shall be properly tin or Electro-silver plated as necessary.

K. Connections from busbar to switching element shall be rated to carry full continuous current rating of switching element frame as a minimum, unless otherwise shown on drawings.

L. Main horizontal busbars and vertical distribution busbars shall be insulated unless bare busbars are recommended by the manufacturer and used in the type test.

M. Full size neutral shall be continuous through all sections. Neutral bus shall be insulated and separate from earth bus and connected to it with removable links, at every bus section. Links shall be of the same cross-section of the earth bus.

N. Earth bus shall extend full length of board, firmly fixed to each section in accordance with the Regulations and Standards, complete with two main earthing lugs (one at each end), and required number of feeder protective earth connectors.

O. Earth bus shall be half size of phase buses, unless otherwise indicated on drawings.

P. Switchboard Type: Switchboard(s) shall be of the following type(s):

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1. Form 3b.
1. Incoming: Withdrawable type – Air Circuit Breaker (ACB).
2. Tie: Withdrawable type - ACB.
3. Outgoing: Fixed type Moulded Case Circuit Breaker (MCCB) for ratings up to 1250A and Withdrawable type ACB for ratings greater than 1250A.

Q. Withdrawable metal enclosed circuit breaker section shall consist of compartmented unit(s), stationary part with rear busbar and cable connection compartments and front draw-out circuit breaker assembly. Partitions between sections shall be bolted steel plate and partitions between compartments shall be tough solid insulating removable bolted barriers. Each unit shall have hinged lockable front door with grip-handle and door mounted instrumentation.

R. Drawout circuit breaker assembly shall have disconnecting contacts, wheels and interlocks to prevent connecting or disconnecting circuit breaker unless in the open position, and to prevent closing circuit breaker while racking into any of the three positions (connect, test, disconnect). Racking mechanism and rail assembly shall be approved worm and lever mechanism. It shall be possible to close the unit door with breaker in any of the three positions and when removed. External position indicator shall be provided. Fixed disconnecting primary contacts shall be accessible and replaceable from front and shall be silver plated copper. Moving primary disconnect contacts shall consist of self-aligning, silver plated, spring pressure, finger-cluster, copper contact fitted on line and load studs of circuit breaker.

S. Fixed main circuit breaker section shall individually accommodate main circuit breaker, main cable entry with terminal fitting assembly and metering compartment. Where placed against a wall, accessibility shall be possible from front and sides or only from front of section.

T. Pull Sections: An additional cable pull section shall be provided, depending on actual configuration shown on the Drawing, and subject to Engineer’s approval.

U. Where busway is used as an incoming or outgoing feeder of the switchboard, the switchboard manufacturer shall provide all necessary accessories as recommended by the busway manufacturer such as adaptor box for the switchboard to be able to accept the busway flange. The contractor is responsible for coordination between the two manufacturers.

V. Where single core cables are used, top / bottom cable entry plates shall be made of bakelite or Aluminum with adequate thickness and rigidity to support cables.

W. Form 1 and form 2 switchboards shall be front accessible, unless otherwise indicated on the Drawings; front, rear or front and rear aligned as recommended by the manufacturer and approved by the Engineer, fixed group mounted MCCB distribution sections, with all devices removable from the front and mounted on a panelboard type base. Construction shall allow all connections and maintenance to be made without rear access. Cables shall be accommodated in extra wide vertical gutters. Sides, top and rear shall be covered with removable screw-on plates having formed edges all around. Front plates shall be sectionalized and removable, covered by trims, and secured by self-tapping screws.

X. Form 3 and form 4 switchboards shall be front and rear accessible unless otherwise indicated on the Drawings; front, rear or front and rear aligned as recommended by the manufacturer and approved by the Engineer, individually mounted fixed MCCB or ACB distribution sections, with compartmentalized construction, consisting of front modular circuit breaker compartments, busbar system compartments and rear cable termination compartments unless otherwise recommended by the manufacturer and approved by the Engineer, with insulating barriers between front compartments and busbar compartments and between rear compartments and busbar compartment (removable for maintenance). MCCBs shall be closely coupled to busbars (to minimize chances of bus-side faults), and to rear cable terminals, through compatibly frame-sized insulated connectors. MCCB modules shall be covered on the front, by recessed frame-type bolted covers, 1.5 mm minimum thickness, to protect circuit breaker handles. Top, sides and rear shall be covered with removable screw-on plates having formed edges all around.

Y. The switchboard shall be designed to minimize the risks associated with the propagation of an internal arc fault of 85 kA for 0.3 sec as a minimum. Switchboard shall be tested in accordance with IEC 61641 for internal arc protection.

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Z. THDi and THDv at the main distribution board section of each transformer (Point of Common Coupling) shall not exceed 10% with 8% individual harmonic order and 5% with 3% individual harmonic order respectively. Necessary supporting calculations based on actual nonlinear loads including VFD, UPS, lighting ballasts, etc. and all other linear loads on the same transformer shall be submitted for Engineer's approval. In case the specified harmonic limits cannot be achieved, the contractor is responsible for achieving the specified limits by providing necessary filters on MDB bus. Adopted solution shall be submitted for Engineer's approval prior to implementation.

AA. All main distribution boards shall be equipped with combined Class I + II surge protective devices as specified under Division W Section " Surge Protective Devices ". SPDs along with their fused-disconnect switch shall be integrated within or adjacent to the MDB's enclosure.

BB. Interface with Generator Synchronization Panel: emergency main distribution board (EMDB) of parallel generators are to be provided with necessary interfaces for connection to the generator synchronization panel. The outgoing circuit breakers of the EMDB are to be provided with electrical motor operators to allow for automatic ON/OFF operation of circuit breakers in accordance with a logic control program at the central control and monitoring management system, such as for load shedding.

CC. Digital multifunctional display unit (MFDU): shall be provided on the main incoming sections of the MDBs. Unit shall be microprocessor based and providing complete electrical metering (kW, kWh, kVA, kVar, power factor, frequency, current per phase, single and composite phase voltage, etc.). Communication to the PMU shall be via a recognized communication protocol. In addition to the above MFDU, 3 analog voltmeters and 3 analog ammeters shall be provided in all MDBs.

120.020 AIR-BREAK METAL ENCLOSED CIRCUIT BREAKER (ACBS)

A. Type: Enclosed in steel structure, air ventilated, air break, for normal operation at maximum temperature within enclosure at point of application, tested to approved standards, manually operated for normal functions, and automatically tripped under over-current conditions. Trip power shall be derived from main power circuit, with sufficient tripping energy to reliably trip circuit breaker. Fixed mounted circuit breaker shall be rear connected.

A. Construction: Manually or manually and electrically operated, as shown on the Drawings, with two-step, spring charged, stored energy mechanism, quick-make, quick-break type, electrically and mechanically trip-free, to prevent maintaining circuit breaker closed against over-current condition whether under manual or automatic operation. Electrically operated circuit breakers shall have integrally mounted, spring charging motor mechanism automatically recharged upon closing. Both manually or manually and electrically operated circuit breakers shall have mechanical built-in charging lever and shall include open and close direct acting push buttons. Stored energy provision shall allow open/close/open sequence of operation without use of external energy. Circuit breaker shall have arc-quenching device on each pole and replaceable arcing contacts.

B. Control Power: For electrically charged circuit breaker and/or for shunt trip device, where required, control power shall be 110V or 120V AC as recommended by the manufacturer obtained from in-built MDB control power transformer connected and fused on line-side of circuit breaker. Where shunt trip and/or under voltage release are required, a sufficient capacitor trip device to cover any temporary loss or excessive drop of supply voltage shall be provided.

C. Rating: 4-pole, with continuous current rating (frame size) as shown on the Drawings, ranging between 1600 A and 5000 A (1600, 2000, 2500, 3000, 4000 and 5000 A), fully rated (100%) for service under worst site conditions. Breakers shall be rated for a symmetrical rms service short-circuit breaking capacity as shown on the Drawings, to IEC 60947-2 sequence II (rated service short-circuit breaking capacity) at specified voltage and frequency, meeting IEC 60947-2, sequence I, II, III and IV tests (for circuit breakers of utilization category B), tested in an enclosure substantially the same as the enclosure in which they shall be installed.

D. Trip Unit: Totally enclosed, programmable, solid state device, interchangeable for compatible frame sizes, pluggable into front of circuit breaker, tamper-proof and with transparent, sealable cover. Trip unit shall measure sinusoidal and non–sinusoidal current wave forms (fundamental to thirteenth harmonic) by continuously sampling each phase through out every cycle. Trip unit shall be direct

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acting trip device, current transformer operated, with flux transfer shunt trip that requires no external power. It shall have adjustable current setting (0.5 - 1.0 times trip unit rating) with adjustable long-time delay up to 24 seconds, short-time pick-up and short-time delay, earth-fault pick-up and time delay instantaneous over current pickup. Current setting range shall be by means of replaceable trip-units within the maximum frame size rating. Once removed, circuit breaker shall remain in the trip-free position. Earth-fault trip shall be adjustable, range 10% to 60% of normal current rating of the circuit breaker and a maximum of 1200A, with adjustable time delay between 0.1 and 0.5 seconds. Short time delay shall be adjustable in steps, 2 - 9 times current setting, with adjustable time delay having maximum delay of up to 0.4 seconds. Instantaneous trip shall be adjustable in steps at least 2 – 13 times the trip unit rating. Over-ride protection shall allow full sensitivity up to interrupting capacity of circuit breaker. Slight difference in setting ranges according to manufacturers standard products may be accepted subject to Engineer's approval.

E. Trip Unit Status Display: Shall indicate in words the status of normal breaker operation, long time over current pick up, instantaneous time over current trip, short time over current trip, ground fault trip. Unit shall have integral resetable counter to count long time, short time, instantaneous and ground fault trips.

F. Position Indicators: Positive with trip indication target. Target indicator shall be mechanical and shall give indication even when control power has been lost.

G. Trip unit shall have inputs from conventional potential transformers for every phase. Current sensors transformers for every phase. Current sensors shall be encased in epoxy filled plastic housing to protect against damage and moisture and shall be integrally mounted in breakers.

H. Neutral current transformer: Provide on the neutral conductor of each main, tie or outgoing circuit having earth fault protection, located after the link connecting neutral and earth busbars from load side. Rating and characteristics of the neutral current transformer shall be suitable for proper operation of the earth fault protection system.

I. Circuit breaker accessories shall include the following:

1. Padlocking or keylocking provisions for all positions (disconnected, test, connected, closing blocking, open)
2. Overload, short-circuit, and ground fault trip LEDS
3. Trip indicator and reset button
4. Operations counter.
5. On/off pilot lights.
6. Shunt-trip coil and closing solenoid for remote control.
7. Bell alarm for remote overcurrent trip indication.

J. Auxiliary Contacts: Include N.O. and N.C. contacts on switchgear as required for remote monitoring and control, plus 2 N.O. and 2 N.C. spare contacts.

K. Electrical Interlock: If electrical interlock is required between power air circuit breakers (as shown on the drawings), the mechanical closing button of the circuit breaker shall be disabled in the connect position and an additional electrical push button shall be provided for the closing of the circuit breaker through the breaker's shunt close coil. The electrical interlock shall be provided on both shunt trip and close coils of the circuit breaker in order to perform simultaneous tripping and inhibit closing functions on the interlocked breaker.

120.030 MOLDED CASE CIRCUIT BREAKERS (MCCBS)

A. Type: Tested to approved standards, , totally enclosed, molded case, constructed from high quality, high temperature resistant, tropicalized, molded insulating materials, for normal operation at maximum temperature within enclosures at point of application, and provided with front operated single toggle type handle mechanism for manual operation of main contacts in addition to automatic operation under over-current conditions. Multi-pole breakers shall have common integral trip bar for simultaneous operation of all poles. Ampere rating shall be clearly visible. All terminals shall be box lug or clamp type with set screws, suitable for copper or aluminum conductors.

A. MCCBs shall be 160 A minimum frame size, unless otherwise shown on the drawings.

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B. MCCBs generally shall be thermal-magnetic type for ratings below 250 A frame size, unless otherwise shown on the Drawings. MCCBs 250 A and larger shall be electronic solid-state trip type. All circuit breakers shall be 3-pole unless otherwise shown on drawings.

C. Thermal magnetic circuit breaker trip units: shall have bi-metallic inverse time delay over-current element for small overloads and instantaneous magnetic over-current trip element for operation under short-circuit conditions on each pole. Circuit breakers rated 150/160 A shall have adjustable instantaneous trips.

D. Electronic trip circuit breakers shall have solid state trip units with long time delay setting range at least between 0.5 and 1.0 times maximum trip rating with adjustable time delay up to 24 seconds, short time delay range 3 to 10 times maximum trip rating with maximum clearing time of 0.2 seconds, and instantaneous protection adjustable from 5 to 10 times continuous rating. Solid state trip units shall be insensitive to changes in ambient temperature between -20 and +55 deg. C. Earth fault protection shall be provided or built into trip unit where specified or shown on drawings, and shall be adjustable between 0.2 and 0.6 normal phase current pick-up with maximum time delay of 0.2 seconds, and shall be suitable for connection to external current sensor. Push-to-trip button shall be provided on cover for testing the trip unit. Short time over current protection is only required for circuit breakers 630A and above.

E. Deration: Thermal and electronic over-current trips shall be ambient temperature derated at specified ambient temperature. In case of adjustable thermal settings, range of adjustment shall not exceed maximum trip rating shown on the Drawings. MCCB shall not be derated if the space where the switch boards are installed is air-conditioned.

F. Switching Mechanism: Quick-make, quick-break type, with positive trip-free operation so that contacts cannot be held closed against excess currents under manual or automatic operation. Contacts shall be non-welding silver alloy with approved arc-quenching devices of metallic grid construction.

G. Trip current rating (amps) indicates nominal maximum rating at which overload element is set to operate.

H. MCCBs: MCCBs frames rated 800 A and above shall have utilization category B (with an intended short time withstand capability), and shall have rated service short circuit breaking capacities (sequence II) with suitably selected frame sizes and trip ranges to meet the electrical requirements at the distribution panelboard location and schedules shown on the drawings, with declared ratings as percentage (100%, 75% or 50%) of the ultimate ratings as quoted by the circuit breaker manufacturer marked on the circuit breaker rating plate. MCCBs frames up to 630 A shall have utilization category A with rated ultimate short circuit breaking capacity (sequence III) to meet the electrical requirements at the switchboards locations.

I. Tripped Position: When tripped automatically by over current condition, operating mechanism of circuit breaker shall assume an intermediate position clearly indicated by the handle between on and off positions.

J. Interchangeable Trips: Thermal magnetic circuit breakers of 150/160 A frame size shall have interchangeable trip units.

K. Sealing: Non-interchangeable trip circuit breakers shall have sealed covers. Circuit breakers with interchangeable trips shall have trip unit covers sealed to prevent tampering.

L. Accessories: Circuit breaker design shall allow addition of open / close electrical motor operator, control and interlocking functions, under-voltage release, shunt-trip coils, alarm and auxiliary switches, padlocking devices, key-lock devices, and the like.

120.040 METERING INSTRUMENTS

A. Generally: Instruments shall be housed in enameled, square, metal cases for flush installation. Scales and markings shall be protected and sealed. Accuracy of instruments shall be within 2% unless otherwise specified.

A. Voltmeters: Moving iron type, with center zero adjuster, range 1.25 times nominal system voltage, 90 degree angle, size 76 x 76 mm.

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B. Voltmeter Selector Switch: 7-position rotary type.

C. Ammeters: Moving iron type, with center zero adjuster, range 2 times nominal circuit amperage, 90 degree angle, size 76 x 76 mm.

D. Provide ammeters and pilot lights for each phase.

E. Provide p.f. meter moving iron type with center zero adjuster, size 76 x76mm.

F. Current Transformer (CT): Indoor dry type, rated secondary current 5 A. Rated primary current, core size and accuracy shall be determined in accordance with nominal current of plant protected, short-circuit level and burden.

G. Voltage Transformer (VT): Provide where required, complete with primary and secondary fuses and disconnecting device.

120.050 DIGITAL METERING UNITS

A. Metering unit shall be provided on the incoming and outgoing feeders having the following functions for each phase:

1. Voltage.
2. Current.
3. Frequency.
4. Energy.
5. Total power.
6. Peak power demand.

A. The metering unit shall be provided by adequate interface link with the BMS system.

120.060 DIGITAL VOLTAGE RELAY

A. This unit shall be provided on the incoming and coupler section to perform the following functions, for connection to the automatic transfer system and monitoring by BMS system:

1. Over-voltage (adjustable from 90 to 120%, with time delay adjustable from 0.5-5 Sec).
2. Under-voltage (adjustable from 75 to 95%, with time delay adjustable from 0.5-5 Sec).
3. Phase Voltage unbalance (detect voltage unbalances over 10%).
4. Phase reversal.

120.070 WIRING

A. Arrangement: Wiring shall be modularly and neatly arranged on master terminal boards with suitable numbering strips and appropriate cartridge type fuses where required.

A. Connections shall be made at front of terminal board and with no live metal exposed.

B. Metal cases of instruments, control switches, relays etc. shall be connected, by bare copper conductors not less than 2.5 mm2 section, to nearest earthing bar.

C. Control Wiring: Copper, PVC insulated, 85 deg. C, 600 V grade, and PVC sheathed for multi-core cables. Finely stranded copper conductor, silicon rubber insulated cables shall be used in proximity to higher temperature components and as flexible cable.

D. Ferrules: Wires shall be fitted with numbered ferrules of approved type at each termination.

120.080 MISCELLANEOUS

A. Anti-condensation heaters with disconnect switch and pilot lamp shall be provided in switchboard, controlled by thermostat and/or hygrostat.

A. Schematic and wiring diagram shall be provided suitably located within each cubicle.

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PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and Division 01 Specification Sections, apply to this Section.

210.000 RELATED SECTIONS

A. Related Sections include the following:

1. Division V Section "Basic Electrical Materials and Methods".
2. Division Y Section " Earthing And Bonding ".
3. Division Y Section "Low Voltage Electrical Power Conductors And Cables".
4. Division W Section " Surge Protective Devices ".
5. Division W Section " Central Control / Building Management ".

PART 3 PRODUCTS AND WORKMANSHIP

300.000 MATERIALS

300.010 MANUFACTURERS

A. Approved Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

1. ABB
2. Cutler – Hammer / Eaton Corp.
3. G.E.
4. Schneider Electric
5. Siemens
6. Schneider Electric / Square D

A. Locally assembled products by one of the above approved manufacturers are acceptable subject to compliance with design requirements and adequacy of reference list and quality control of the local factory.

100.030 PRODUCTS

B. Products: Subject to compliance with requirements, provide one of the products indicated for each designation as shown on plans.

310.000 QUALITY MANAGEMENT

310.010 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer with minimum five years of successful installation experience on projects utilizing main distribution boards units similar to those required for this project.

B. Manufacturer Qualification: A firm regularly engaged in the manufacture of main distribution boards, of types, sizes, and capacities required, and whose products have been in satisfactory use in similar service for not less than five years.

C. Compliance with Local Requirements: Comply with applicable local regulations/code requirements of authorities having jurisdiction. These will have precedence over other codes/standards nominated for the project, unless otherwise approved in writing.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for main distribution boards, including clearances between main distribution boards, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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100.040 DELIVERY, STORAGE AND HANDLING

A. Deliver in sections of lengths that can be moved past obstructions in delivery path.

B. Deliver, store, and handle materials, components, and equipment as per Manufacturer's instructions.

100.050 COORDINATION

C. Coordinate layout and installation of main distribution boards and components with other construction and electrical work, including conduit, piping, equipment, adjacent surfaces, raceways, electrical boxes and fittings, and cabling/wiring work. Maintain required workspace clearances and required clearances for equipment access doors and panels.

D. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division E Section " Accessories Cast Into In Situ Concrete."

100.060 WARRANTY

E. Manufacturer's Warranty: Submit a written warranty signed by the manufacturer agreeing to repair, restore or replace any defective equipment specified in this section during the specified warranty period

1. Warranty Period: 1 year from date of Substantial Completion.

100.070 SPARE PARTS AND EXTRA MATERIAL

F. Spare Parts: Provide manufacturer's recommended spare parts for emergency replacement and/or one year's maintenance including, but not limited to, the following:

1. One set of fixed and moving contacts for every type of replaceable (consumable) contact set.
2. One operating motor and/or coil for each type of electrically operated circuit breaker.
3. Two sets of each type of indicating lights, fuses, LEDs, control switches, and similar devices subject to failure or breakage at any time.

G. Tools and Instruments: Provide tools and instruments required for normal routine inspection and maintenance and testing of circuit breakers and protective devices as appropriate for type of switchgear supplied.

320.000 SUBMITTALS

A. Product Data: Submit for approval detailed description of main distribution boards including all components supported by manufacturer's catalogues, indicating compliance with the Standards specified under "Quality Assurance" Article, equipment characteristics, details of construction, operating data, dimensions and weights etc. Give details of miscellaneous items including incoming and outgoing feeder terminal arrangement, connections at busbars, isolating, earthing, interlocks, control devices, indicating and metering instruments etc. Boards shall be factory assembled and tested and shipped as complete package (s).

A. Shop and Construction Drawings: Submit drawings for approval including, but not limited to, the following:

1. Plans and elevations with indication of built-on equipment, exact dimensions, and weights.
2. Arrangement of boards inside rooms allocated, indicating spaces and clearances.
3. Arrangement of equipment inside board.
4. One-line diagram of power system showing current ratings of switchgear and busbars and types and locations of protective gear (relays, instruments, CTs, VTs etc.)
5. Schematics and wiring diagrams of control circuits. Differentiate between manufacturer-installed and field-installed wiring.
6. Foundation details and grouting holes installation details.
7. Arrangement of incoming and outgoing feeders, terminal fittings, instruments, busbar connections etc.
8. Utility Company's metering provisions with indication of approval by utility company.

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B. Point-wise compliance statement to the specifications, duly signed by the manufacturer / manufacturer's authorized representative and the contractor.

C. Technical Literature: Submit the following for approval prior to placing orders for equipment manufacture:

1. Schedule of circuit breakers application, indicating type, range, features and characteristics, short- circuit ratings, time-current curves etc.
2. Method of setting of protective devices for overload, short-circuit and earth-fault currents as coordinated with upstream and downstream systems based on specific coordination curves of protective devices used and specific calculated prospective short-circuit currents at various points.
3. Test methods on site and references, including testing equipment for microprocessor controlled trip units.

D. Qualification Data: For firms and persons specified in "Quality Assurance" Article. Provide evidence of applicable registration or certification.

E. Tests and Certificates: Submit complete certified manufacturer's type and routine test records, in accordance with the Standards specified in "Quality assurance" Article.

F. Field Test Reports: Submit written test reports and include the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

G. Manufacturer's field service report.

H. Maintenance Data: For main distribution boards and components to include in maintenance manuals specified in Division 01. In addition to requirements specified in Division 01 include the following:

1. Routine maintenance requirements for main distribution boards and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Time-current curves, including selectable ranges for each type of overcurrent protective device.

I. Coordination Study: Submit coordination study along with setting of protective devices for overload, short-circuit and earth-fault currents as coordinated with upstream and downstream systems based on specific coordination curves of protective devices used and specific calculated prospective short-circuit currents at various points.

330.000 EXECUTION

330.010 EXAMINATION

A. Examine elements and surfaces to receive main distribution boards for compliance with installation tolerances and other conditions affecting performance. Notify Engineer in writing of conditions detrimental to proper completion of the work.

A. Proceed with installation only after unsatisfactory conditions have been corrected.

330.020 INSTALLATION

A. Install main distribution boards as indicated, in accordance with manufacturer's written instructions, and with recognized industry practices; complying with applicable requirements of applicable standards or codes approved.

A. Equipment Bases: Ensure that concrete bases and foundations provided for installation of equipment are constructed in accordance with approved shop and construction drawings and equipment manufacturers' drawings and that holes for fixing bolts and provisions for passage of cables etc. are provided as required.

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B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from main distribution board units and components.

C. Cable Trenches: Ensure that trench construction and covers provided for installation of power and control cables are in accordance with approved shop and construction drawings.

D. Built-in Items: Ensure that equipment supports, fixings and the like, and sleeves for passage of feeders and cables which shall be built into concrete foundations, bases, cable trenches or building structure are provided as and when required and that they are properly installed.

E. Equipment: Install on concrete bases etc., and assemble completely plumb and level, before grouting in holding-down bolts.

F. Supports and Terminations: Install all incoming and outgoing cable supports, cable ends and termination fittings required for power and control cables.

G. Relays: Set in accordance with manufacturer's instructions and in accordance with an approved scheme.

H. Make Good damage painted surfaces, clean and apply rust-inhibiting prime coat and two finishing coats of approved enamel upon delivery of equipment to site, or as required by Engineer.

I. Operating Instructions: Frame and mount the printed basic operating instructions for main distribution boards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of main distribution boards.

330.030 FACTORY ACCEPTANCE TEST

A. Factory acceptance tests of equipment under this Contract are subject to be witnessed by the Engineer for locally assembled equipment. Witness test shall include complete routine and function testing on all units to be witnessed. Test procedure and program shall be submitted for approval prior to test conduction. Allow for test expenses including business class transportation and hotel accommodation as necessary for two persons from the Engineer's/ Employer's side.

330.040 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division V Section "Basic Electrical Materials and Methods."

A. Main Distribution Board Nameplates: Label each main distribution board compartment with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

330.050 CONNECTIONS

A. Install equipment-grounding connections for main distribution boards with ground continuity to main electrical ground bus.

A. Tighten electrical connectors and terminals, including screws and bolts, according to manufacturer's published torque-tightening values and / or recommendations. If manufacturer's torque values are not indicated, use those specified in applicable Standards.

330.060 FIELD QUALITY CONTROL

A. Equipment: Inspect equipment upon delivery to Site and report any damage to Engineer.

A. Switchgear: Inspect and check switchgear for completeness, component ratings, types, sizes, and wiring connections. Check phasing of busbars, contacts and clearances.

B. Prior to energization of circuitry, check all accessible connections to manufacturer's torque tightening specification.

C. Tests: After installation and before hand-over, carry out all visual and mechanical inspection and electrical tests required by the governing codes and any other tests the Engineer may require to check compliance of installation with the Specification, including, but not limited to, the following.

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Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

1. Insulation resistance tests for each main distribution board bus, component, connecting supply, feeder, and control circuit.
2. Continuity tests of each circuit.
3. Operational tests.

D. Main and Control Circuits: Using 1000 V megger (2000 Megohm range), check insulation resistance between phases, between phases and earth/enclosure and between neutral and earth.

E. Primary Injection Tests: Provide portable test equipment to test time-delay characteristics of circuit breakers by simulating an overload or fault condition. Measure and record all test results and ambient conditions and compare with manufacturer's data.

F. Instantaneous Trip Elements: Test by high current primary injection, using high-current primary injection test-sets and reports all readings.

G. Routine Tests on Site: Carry out on every main distribution board in accordance with the Standard specified (IEC 61439-1 and IEC 61439-2) for FBAs assembled from standardized components outside the works of the manufacturer. Routine tests are also to be carried out on every FBA, delivered to site, if requested by Engineer.

330.070 CLEANING

A. On completion of installation, inspect interior and exterior of main distribution boards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

330.080 ADJUSTING

A. Set field-adjustable switches and circuit breaker trip ranges.

330.090 DEMONSTRATION AND TRAINING

A. Train Employer's maintenance personnel to adjust, operate, and maintain the system installation. Refer to Division A Section "Demonstration and Training and Closeout Procedures."

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Y71B - PANELBOARDS

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. Panelboards for distribution and sub-distribution of electric power and for protection of circuits, including fixing and supporting materials and materials for termination of feeders, sub-circuits and branch circuits for the following types:

1. Lighting and appliance branch-circuit panelboards.
2. Distribution panelboards.
3. Feeder pillars for power distribution and external lighting.

B. Connection to BMS system, including interface elements such as relays, transducers, etc. as detailed in Division W Specification Sections BMS schedules and /or shown on the Drawings.

110.000 DESIGN PARAMETERS

110.010 DEFINITIONS AND ABBREVIATIONS

A. MCB: Miniature circuit breaker.

B. MCCB: Molded case circuit breaker.

C. LP, PP, SDP: Final branch circuit panelboards, power panelboards and sub-distribution panelboards respectively, for secondary lighting and power distribution with either miniature circuit breaker (MCB) or molded case circuit breaker (MCCB) protection on sub-feeder or branch circuits, as shown on the Drawings.

D. DP: Distribution panelboards for power distribution with MCCB protection on main incoming and outgoing feeder circuit breakers Type 1 or Type 2.

E. Distribution panelboards or final branch circuit panelboards supplied from emergency source are prefixed with the letter “E” if supplied from emergency source, and with letter “U” if supplied from UPS source. Isolated power panels shall be identified as “IPP”.

F. ELCB: Earth leakage circuit breaker.

G. RMS: Root mean square.

110.020 REFERENCE STANDARDS

A. Comply with

1. IEC 61439-1 & IEC61439-2 "Low Voltage Switchgear and Control Gear Assemblies".
2. IEC 61439-3 "Low Voltage Switchgear and Control Gear Assemblies - Distribution boards intended to be operated by ordinary persons (DBO)".
3. IEC 60947-1 "Low Voltage switchgear and control Gear- General Rules".
4. IEC 60947-2 "Low Voltage switchgear and control gear - circuit breakers".
5. IEC 60947-3 "Low Voltage switchgear and control gear - Switches, disconnectors, switch-disconnectors and fuse-combination units circuit breakers".
6. IEC 60947-4-1 "Low Voltage switchgear and control gear - Contactors and motor-starters — Electromechanical contactors and motor-starters".
7. IEC 60898-1 "Miniature circuit breakers".
8. IEC 61009 "Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs)".
9. Other components where not specified shall comply with the relevant IEC standards.

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120.000 SYSTEM DESCRIPTION

120.010 GENERAL REQUIREMENTS

A. Rated insulation voltage shall be in accordance with the respective standards.

B. Panelboards shall be totally enclosed, dead front type, protection code IP 31 for indoor installations, IP54 for installations in wet areas and IP 55 for outdoor installations, in accordance with IEC 60529, and shall be factory designed and assembled.

C. Earthing bar shall be half size the phase busbars.

D. Neutral bar shall be sized as the phase bus bars.

E. Protection shall be fully rated throughout the systems.

F. Circuit breakers shall be non-fused type.

G. Circuit Breaker Arrangement: Panelboards shall have one main incoming circuit breaker or switch and the required number of branch circuit breakers, arranged as shown on the schedules, including spare circuit breakers and spaces for future expansion. Three-phase panelboards shall be designed for sequence phase connection of branch circuit devices.

H. Branch Circuit Numbering: On 3-phase panelboard schedules, circuits 1 and 2 shall be connected to brown (BN) phase, 3 and 4 to black (BK) phase, 5 and 6 to grey (GY) phase etc., to conform with branch circuit numbering shown on the drawings.

I. Spare capacity: Provide a minimum of 20% spare circuit breakers capacity for all types of panelboards.

J. Terminal blocks: shall have current and voltage ratings appropriate for the application.

120.020 PANELBOARD ENCLOSURES

A. Type: General purpose type, suitable for relevant ambient conditions, flush or surface mounted as shown on the drawings, comprising box, trim, or trim and door to approved manufacturer's standards and sizes.

B. Construction: Box, trim and doors where required, shall be Electro-galvanized sheet steel of gauges not less than specified and in accordance with the standards. Welded joints shall be galvanized after manufacture. Gutter spaces shall conform to the standards, adequate for the utilized cables/wires subject to the Engineers' approval and in no case less than 100 mm on all sides. Enclosure shall have pre-designed angles or threaded end studs to support and adjust mounting of interior panelboard assembly.

C. Trims shall cover and overlap front shield, covering all terminals and bus compartments, to form a dead front panel. Trims shall be fixed to cabinet/box by quarter-turn clamps engaging flange of box (use of screws engaging holes in flange of box is not acceptable). Screws where used shall be oval-head, countersunk and flush. Trims for flush mounted panelboards shall overlap box and front shields by at least 20 mm. Trims for surface mounted panelboards shall be exactly sized to form flush fit to box.

D. Doors shall have concealed hinges integral with trim, and flush combination cylinder lock and catch. Doors over 1000 mm high shall have vault-type handle and multiple point latch mechanism. Locks shall be keyed alike.

E. Finish: Inner and outer surfaces of cabinet/boxes, trims, doors etc. Shall be cleaned, phosphatized, chrome passivated and treated with final thermosetting epoxy powder modified by polyester resins providing high resistance to mechanical injury, heat, acid and alkali solvents, grease, aging and corrosion and of standard gray color to the approval of Engineer.

F. Directories under glassine, or an approved alternative durable arrangement, shall be provided on inside face of doors, or in metal label holders when trim without doors are specified. Directories shall be typed to identify panelboards and clearly indicate circuit number and description of load.

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G. Outdoor enclosures shall be heavy duty sheet steel cabinets, suitable for mechanical impact resistance of IK10 to IEC 62262, fully weatherproofed (IP 54), without knockouts, but with removable sealed/gasketed bottom gland plates and gasketed doors.

H. Where single core cables are used, top / bottom cable entry plates shall be made of bakelite or Aluminum with adequate thickness and rigidity to support cables.

120.030 BUSBARS

A. Type: One piece, 98% pure electrolytic copper, tin-plated, based on total maximum operating temperature of 90 deg C at any point of the bus, at full continuous rating. Bolted or clamped contact surfaces shall be properly tin or silver plated as necessary, and shall have maximum current density not exceeding requirements of the approved standards. Aluminum shall not be used for busbars or panelboard parts.

B. Design: Busbars shall be rigidly designed so that branch circuit devices can be removed without disturbing adjacent units or changed without additional machining, drilling or tapping. Busing shall be full size without reduction. Busing and blank plates shall allow installation of future circuit devices, where indicated on the drawings.

C. Main horizontal busbars and vertical distribution busbars shall be insulated unless bare busbars are recommended by the manufacturer and used in the type test.

D. Rating: Busbar rating shall be at least equal to main-circuit breaker frame size. Where no main circuit breaker is required, busbars shall have main lugs or disconnect switch, with nominal rating equal to 1.25 times the up stream circuit breaker trip rating, and as shown on the drawings.

E. Short-circuit Duty: Busbars shall carry at least 125% of the maximum short-circuit level at point of application for one second, without showing any signs of degradation.

F. Terminals and connections shall be anti-turn, solder-less screw-pressure type. Screws and bolts used for making copper/copper connections shall be hard copper alloy with lock washers (riveted bus connections are not acceptable).

G. Neutral bar shall be solid and fully insulated from cabinet or box. One solder-less box type set-screw connector shall be provided for neutral wire of each branch circuit and one bolted clamp-type connector or anti-turn lug with set-screw for main incoming neutral wire. Neutral shall be fully sized and rated as for phase busbars.

H. Earthing bar shall be copper, brazed to panelboard cabinet, with bolted pressure connector for main conductor and one set-screw-type tunnel terminal for each outgoing conductor, to provide secure and reliable contact with all metal parts and enclosure.

120.040 MOULDED CASE CIRCUIT BREAKERS (MCCBS)

A. Type: Tested to approved standards, , totally enclosed, molded case, constructed from high quality, high temperature resistant, tropicalized, molded insulating materials, for normal operation at maximum temperature within enclosures at point of application, and provided with front operated single toggle type handle mechanism for manual operation of main contacts in addition to automatic operation under over-current conditions. Multi-pole breakers shall have common integral trip bar for simultaneous operation of all poles. Ampere rating shall be clearly visible. All terminals shall be box lug or clamp type with set screws, suitable for copper or aluminum conductors.

B. MCCBs shall be 160 A minimum frame size, unless otherwise shown on the drawings.

C. Circuit Breaker Trip Units: Unless otherwise specified or shown on the drawings, moulded case circuit breakers of final branch circuit panel boards (LPs), power panel boards (PPs) and sub-distribution panel boards (SDPs) shall be thermal magnetic type, while moulded case ciruit breakers of distribution panel boards (DPs) shall be thermal magnetic for frame sizes up to 160 amperes and electronic type for higher frame sizes.

D. Thermal magnetic circuit breaker trip units: shall have bi-metallic inverse time delay over-current element for small overloads and instantaneous magnetic over-current trip element for operation under short-circuit conditions on each pole. Circuit breakers rated 150/160 A shall have adjustable instantaneous trips.

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E. Deration: Thermal and Electronic over-current trips shall be ambient temperature derated at specified ambient conditions and corresponding temperature within the enclosures. MCCB shall not be derated if the space where the panels are installed is air-conditioned.

F. Electronic trips units, applicable to circuit breakers 250 A frame size and larger, shall be solid state with long time delay settings between 0.5 and 1.0 times maximum trip rating, short time delay range of 3 to 10 times maximum trip rating with a maximum clearing time of 0.2 seconds, and instantaneous protection adjustable from 5 to 10 times continuous rating. Solid state trip units shall be insensitive to changes in ambient temperature between -20 and +55 deg C. Earth fault protection shall be built into trip unit where specified, and shall be suitable for connection to external current sensor. Push-to-trip button shall be provided on cover for testing the trip unit. Short time over current protection is only required for circuit breakers 630A and above.

G. Switching Mechanism: Quick-make, quick-break type, with positive trip-free operation so that contacts cannot be held closed against excess currents under manual or automatic operation. Contacts shall be non-welding silver alloy with approved arc-quenching devices of metallic grid construction.

H. Trip current rating (amps) indicates nominal maximum rating at which overload element is set to operate.

I. MCCBs for LPs, PPs, SDPs, DPs Type 2 and feeder pillars: Comply with IEC 60947-2 test sequences I, II, utilization category A, and shall have rated ultimate short circuit breaking capacities (sequence III) to meet the electrical requirements at the panelboard location, with preferred ratings in accordance with following tables.

J. MCCBs for DP Type 1: MCCBs frames rated 800 A and above shall have utilization category B (with an intended short time withstand capability), and shall have rated service short circuit breaking capacities (sequence II) with suitably selected frame sizes and trip ranges to meet the electrical requirements at the distribution panelboard location and schedules shown on the drawings, with declared ratings as percentage (100%, 75% or 50%) of the ultimate ratings as quoted by the circuit breaker manufacturer marked on the circuit breaker rating plate. MCCBs frames up to 630 A shall have utilization category A with rated ultimate short circuit breaking capacity (sequence III) to meet the electrical requirements at the panel boards locations with preferred ratings in accordance with the below tables.

K. Frame size is defined as maximum continuous current rating of circuit breaker which corresponds with its maximum trip range listed below and which shall be related to minimum acceptable short-circuit interrupting ratings, based on fully rated interrupting duties: normal duty (N), high break (H), or current limiting (L), as specified.

L. Frame sizes are generally to be selected with minimum interrupting capacities at specified voltages and rated frequency, in accordance with the following table:

Trip range frame size(amperes)	Minimum Symm. rms rated breaking capacity (ultimate in kA)			Rating volts(A.C.)
	N	H	L	
Thermal-magnetic				
15-100 or 160 (1,2p)	18	-	-	230
15-100 or 160 (2,3,4p)	18	-	-	400
15-160 (2,3,4p)	35	60	100	400
Electronic				
100-250 (2,3,4p)	35	60	150	400
160-400 (3,4p)	35	60	150	400
250-630 (3,4p)	40	60	150	400
320-800 (3,4p)	50	60	150	400
500-1250 (3,4p)	50	70	150	400

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M. Tripped Position: When tripped automatically by over-current condition, operating mechanism of circuit breaker shall assume an intermediate position clearly indicated by the handle between on and off positions.

N. Interchangeable Trips: Thermal-magnetic trip circuit breakers of 150/160 A frame size shall have interchangeable trip units.

O. Sealing: Circuit breakers with non-interchangeable trip units shall be sealed. Circuit breakers with interchangeable trip units shall have trip unit covers sealed to prevent tampering.

P. Accessories: Circuit breakers shall be designed to accommodate standard attachments including shunt-trip, under-voltage release, combined auxiliary and alarm switches, and open / close electrical motor operator to any circuit breaker of rating (frame size) 100 A and over. Padlocking devices shall be provided, where shown on the Drawings.

Q. Residual current operated circuit-breakers with integral overcurrent protection (RCBOs) type A to IEC 61009 are provided as add-on or built-in earth leakage accessories, where required and as shown on the Drawings. Protection against earth fault current, in addition to over-current and short-circuit protection, shall be in accordance with the Regulations. Trip current sensitivity on breakers for branch circuits shall be as shown on the Drawings, and for main breakers ratings shall be as shown on the Drawings. Circuit breakers shall include current transformer with tripping coil assembly, test button and trip free mechanism to ensure circuit breaker cannot be held closed against earth faults.

R. Current Limiting Circuit Breakers: Molded case type without fusible elements. When operating within current limiting range, the I^2t of let-through current shall be less than 1/2 cycle wave of symmetrical protective short-circuit current as compatible with breaker construction.

S. Current limiting circuit breakers shall have, on each pole, adjustable inverse time-delay over-current characteristics for overload protection and instantaneous trip for short-circuit protection. Operation of main contacts shall be based on Electro-magnetic repulsion forces between contacts created by fault current. Ratings are specified at rated voltage for an rms value of prospective short-circuit current.

120.050 MOLDED CASE SWITCHES (MCSS)

A. Molded Case Switch: Similar to circuit breakers but without overload/short circuit protection. Short time rating of switches shall not be less than twelve times the maximum rated operational current for 1 second. Switches shall comply with IEC 60947-3. Switches shall have utilization category AC-22B to IEC 60947-3.

120.060 MINIATURE CIRCUIT BREAKERS (MCBS)

A. Type: Thermal magnetic non-adjustable type, tested in accordance with IEC 60898-1.

B. Minimum short-circuit breaking capacities to IEC 60898-1shall be as follows:

1. 6 - 125A MCB :

10 or 15 kA at 220/240 - 380/415 V A.C.

C. Construction: MCBs shall be tropicalized for operation at ambient temperatures up to 70 degree C within panelboard enclosure and humidity up to 95%, and shall be constructed from high quality, high temperature, molded insulating materials. Guaranteed duties and characteristics shall be submitted for temperatures at and above 40 deg C.

D. MCBs and combination devices shall be modular, of unified profile and suitable for mounting either to a standard din rail, or a plug-in system.

E. Operation: Under overload conditions, thermal tripping shall provide close protection of insulated conductors. Under short-circuit conditions, magnetic trip shall operate at 5 - 10 times normal rated current (Curve C). Magnetic operation shall be in the current limiting region and opening time shall not exceed 5 milliseconds.

F. Ratings: Preferred rated currents shall be 6, 10, 15, 20, 25, 30, 40, 50, 60, 80, 100 and 125 A, calibrated at 40deg.c, available as 1, 2, 3 and 4-pole circuit breakers. De-rating above 40 deg C shall not exceed 1% per deg C and loading shall not exceed 70% of circuit breaker rating.

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G. Residual current devices for earth leakage protective circuit breakers shall be add-on devices, or built-in and integral with the standard circuit breaker. Non-adjustable sensitivities of 30 mA, 100 mA and 300 mA shall be available for all ratings of 2-pole and 4-pole circuit breakers.

H. Auxiliaries where shown on the drawings, shall include alarm switch, auxiliary switch, shunt trip, under voltage trip and similar units which shall be modular additions to the circuit breakers.

120.070 DISTRIBUTION PANELBOARDS (DP)

A. DP Type 1: Form 2b to IEC 61439-1&-2, and have a minimum rated insulation voltage of 750V and with 8 kV impulse withstand voltage, free standing , with doors (unless otherwise shown on the Drawings), suitable for ratings of main breaker and busbars ranging from 630 A to 1250 A, 3-phase, 4-wire (or 3-wire where specifically indicated), suitably and orderly arranged for any selected combination of branch MCCBs ranging from 150/160 A to 1250 A frame size and short-circuit interrupting ratings as shown on the Drawings. Circuit breakers smaller than 250 A frame size, where indicated, may be grouped on an integral sub-assembly mounted to main chassis.

B. DP Type 2: Form 2a to IEC 61439-1&-2, and have a minimum rated insulation voltage of 690V and with 8 kV impulse withstand voltage. Panelboard shall be recessed or surface mounted type, as shown on the Drawings, complete with trim and door, adjustable trim fixation for flush panels, and with ratings of main circuit breaker and busbars up to 400 A, 3-phase, 4-wire, with 2 or 3-pole branch circuit breakers, 100 A or 150/160 A or 250 A frame size.

C. Circuit breakers for DP's shall be fitted with a plug-in base type of modular construction complete with its accessories; non draw-out type.

D. Construction: Sheet steel, for cabinet/box; suitable for mechanical impact resistance of IK10 to IEC 62262 for enclosures protection degree IP54 and higher and IK08 to IEC 62262 for enclosures protection degree lower than IP54. Test certificates for mechanical impact shall be submitted for approval; otherwise enclosure thickness shall not be less than 1.5mm. Fronts shall be single or twin covers to shield circuit breakers, terminals and live ends.

E. All distribution panelboards shall be equipped with Class II surge protective devices as specified under Division W Section "Surge Protective Devices ". SPDs along with their fused-disconnect switch shall be integrated within or adjacent to the DP's enclosure.

F. Interior of panelboard shall be pan assembly consisting of galvanized sheet steel chassis , folded, flanged and reinforced, with busbars vertically arranged and mounted on molded insulators.

G. Molded insulators shall have minimum temperature rating of 130 deg C and insulation grade of 3.5 kV for one minute.

H. Circuit breakers shall be mounted in twin arrangement (except for larger circuit breakers) and bolted rigidly to copper cross and center bus connectors.

I. Metering Instruments: Instruments shall be housed in enameled, square, metal cases for flush installation. Scales and markings shall be protected and sealed. Accuracy of instruments shall be within 2% unless otherwise specified.

1. Voltmeters: Moving iron type, with center zero adjuster, range 1.25 times nominal system voltage, 90 degree angle, size 76 x 76 mm.
2. Voltmeter Selector Switch: 7-position rotary type.
3. Ammeters: Moving iron type, with center zero adjuster, range 2 times nominal circuit amperage, 90 degree angle, size 76 x 76 mm.
4. Ammeter Selector Switch: 4-position rotary type.
5. Provide ammeters and pilot lights for each phase.
6. Current Transformer (CT): Indoor dry type, rated secondary current 5 A. Rated primary current, core size and accuracy shall be determined in accordance with nominal current of plant protected, short-circuit level and burden.
7. Voltage Transformer (VT): Provide where required, complete with primary and secondary fuses and disconnecting device.

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120.080 FINAL BRANCH CIRCUIT, POWER AND SUB-DISTRIBUTION PANELBOARDS - GENERALLY

A. Arrangement: Comprise set of homogeneous branch circuit breakers with unified profile and base, and one main circuit breaker or switch as shown on drawings. Single and multi-pole circuit breakers or other devices shall occupy modular spaces. Accommodation of contactors and split-bus arrangement or other devices shall not change regularity of standard box width.

B. Indoor Enclosure: Sheet steel, minimum 0.8 mm thick for box/cabinet and minimum 1.5 mm thick for front shield, trim and door. Fixings for flush trim shall be adjustable to allow for mis-alignment between box and wall surface. Wiring spaces (gutters) shall be at least 100 mm wide. Larger gutters shall be provided where tap-off insulated split connectors are required. Knockouts shall be provided in top or bottom of enclosures and shall provide a neat and uniform conduit/cable terminal arrangement.

C. Contactors: 2 or 3-pole, Electro-magnetic type, class AC 5a for discharge lamps, class AC 5b for tungsten halogen lamps and class AC 3 for motors to IEC 60947-4, and rated not less than overload setting of protective device upstream. Contacts shall be double break, silver cadmium plated, having self-cleaning wiping action. Control shall be provided by phase-neutral (maximum 230 V) split-coil, for on/off activation by local and/or by remote direct-wired, on/off push buttons. Contactor shall be mechanically latched. Control circuit shall be fused. Auxiliaries shall include local pilot light, parallel remote indicating circuit, 2 N.O. and 2 N.C. auxiliary contacts.

D. All final branch circuits feeding sensitive electronic equipment such as: electronic equipment and telecom racks shall be equipped with class III surge protective devices as specified under Division W Section "Surge Protective Devices ". SPDs along with their fused-disconnect switch shall be integrated within the panelboard’s enclosure.

120.090 FINAL BRANCH CIRCUIT, POWER AND SUBDISTRIBUTION PANELBOARDS - TYPE MCCB

A. Type: Rated insulation voltage rating 690V as a minimum. single-phase and neutral (SPN) or 3-phase and neutral (TPN), with bolted 1, 2, or 3-pole MCCBs on branch circuits and 2, 3 or 4-pole MCCB on main incoming.

B. Branch circuit breakers shall be 1, 2 or 3-pole, rated 100 A frame size, with trip ratings between 15 A and 100 A, and compatible ICs, selected from normal (N), high-break (H) or current-limiting (L) range.

C. Main incoming circuit breaker shall be 100 A or 160 A frame size as shown on the drawings, with trip ratings and fully rated non-current limiting ICs of normal (N) or high-break (H) ranges, with or without residual current device (RCBO) as indicated on the Drawings.

D. Assembly: Busbars shall be rigidly fixed on molded insulators to back pan in vertical arrangement. Branch circuit breakers shall be bolted in twin arrangement to rigid copper cross and center bus connectors. Back pan assembly shall be removable and fixed to four threaded studs integral with cabinet.

120.100 FINAL BRANCH PANELBOARDS - TYPE MCB

A. Type: Rated insulation voltage rating of 500V as a minimum.

B. Internal Assembly: Comprise removable back plate or back pan of rigid construction, attached to enclosure by four captive screws through keyhole fixings, and provided with DIN rails in horizontal arrangement for SPN panels and in vertical arrangement for TPN panels. Assembly shall be complete with neutral terminal block, earthing bar and one piece insulated bolt-on/comb-type phase busbar. Busbars shall be single-phase or 3-phase with spade connectors for fixing by tightening a single screw on circuit breaker. Insulation shall be high thermal rating, capable of carrying maximum short-circuit current for one second without overheating beyond acceptable limits required by the Standards. Panelboards shall comply with IEC 61439-3.

C. Internal Assembly: Comprise removable back plate or back pan of rigid construction, attached to enclosure by four captive screws through keyhole fixings, and provided with busbars in horizontal arrangement for SPN panels and in vertical arrangement for TPN panels. Assembly shall be

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complete with neutral terminal block, earthing bar and one-piece insulated phase busbar. Busbars shall be single-phase or 3-phase with spade connectors for fixing by tightening a single screw on circuit breaker. Insulation shall be high thermal rating, capable of carrying maximum short-circuit current for one second without overheating beyond acceptable limits required by the Standards.

D. SPN type panelboards shall be suitable for 240 V maximum service voltage, single-phase and neutral, with MCBs on branch circuits and main incoming.

E. SPN type main circuit breaker shall be double-pole MCB, with or without earth leakage device (RCBO), as shown on the Schedules.

F. Single-pole and double-pole MCBs for 240 V service, shall have trip ratings between 6 A and 125 A, with ICs as required in the Schedules.

G. TPN type panelboards shall be suitable for up to 415 V A.C. maximum service voltage, 3-phase and neutral, with MCBs on branch circuits and 3 or 4-pole MCCB or MCS main incoming, as shown in the Schedules or on the Drawings.

H. Triple-pole branch circuit breakers shall have trip ratings between 6 A and 125 A, with IC as required in the Schedules.

I. TPN type panelboard main circuit breakers shall be MCCB or MCS as shown on the drawings, 100A or 160A frame size as shown on the Drawings, with trip range from 32 A to 160A, normal (N) or high-break (H) duty with/without RCBO as shown on the Drawings.

J. Short-circuit Rating: TPN panelboards may only have integrated equipment (series) short-circuit ratings in accordance with clause paragraph F of Article 120.010 "GENERAL REQUIREMENTS" hereof.

120.110 FINAL BRANCH CIRCUIT PANELBOARDS; SPLIT-BUS MCCB/MCB TYPES

A. Assembly shall be as specified for MCB or MCCB type of branch circuit panelboard, but with split-bus arrangement, part of which is controlled by in-built submain circuit breaker or circuit breaker and contactor for group control of a number of branch circuits. Panelboard shall have main circuit breaker for protection and isolation.

120.120 FEEDER PILLARS FOR POWER DISTRIBUTION AND EXTERNAL LIGHTING

A. Low voltage feeder pillars shall comply with IEC 61439-1 and IEC 61439-5.

B. Type: Rated insulation voltage rating 690V as a minimum. 3-phase and neutral (TPN), with bolted 1, or 3-pole MCCBs on outgoings and 3-pole MCCB on main incoming.

C. Construction: the feeder pillar shall be totally enclosed, dead front type, fully self-contained, dust-proof, weather proof and suitable for mounting outdoors exposed to dust, rain and sunlight with IP55 degree of protection to IEC 60529.

D. Cabinets: Reinforced free standing structure with high mechanical impact resistance IK10 to IEC 62262, manufactured from 2 mm nominal thickness galvanized sheet steel, electrostatically powder coated and corrosion resistant internally and externally. Feeder pillars shall be provided with bolted reinforcement corner construction and shall be of the dwarf type with a bolting down root for mounting on a pre-formed concrete base suitable for all incoming and outgoing cables from below ground level directly buried or in a duct system. Feeder pillars shall have suitable extension cable box for cable entry from below. Cabinets shall have two hinged lockable opening doors to provide full front access to the cabinet and shall be sized according to the equipment being installed. The roof of the cabinet shall be slanted and shall have water drip edges.

E. Lighting Contactors: 2 or 3-pole, Electro-magnetic type, class AC 5a for discharge lamps or AC 5b for tungsten halogen lamps to IEC 60947-4, and rated not less than the frame size of the upstream protective device. Contacts shall be double break, silver cadmium plated, having self-cleaning wiping action. Control shall be provided by phase-neutral (maximum 230 V) split-coil, for on/off activation by local and/or by remote direct-wired, on/off push buttons. Contactor shall be mechanically latched. Control circuit shall be fused. Auxiliaries shall include local pilot light, parallel remote indicating circuit, 2 N.O. and 2 N.C. auxiliary contacts.

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F. Internal Cabling: PVC/PVC single core 600/1000 volt grade with copper conductors and rated as required taking into account manufacturers recommended temperature and bunching derating factors. All internal wiring shall be suitably laced or clipped.

G. Control: LV panel circuits serving the street and outdoor lighting shall be supplied through triple pole contactors which shall be photo-electric, timer controlled along with BMS control, where shown on the Drawings. The contactors shall be operated through either timer or photoelectric cell or remote signal from BMS. An over-ride facility shall be provided for maintenance.

H. The photo-electric relays shall be solid state, with single-pole, double-throw dry contacts rated to operate connected relay or contactor coils or microprocessor input, with light level monitoring ranging from 0 to 37000 lux, with an adjustment for turn-on/turn-off levels and with time delay to prevent false operation. Relays shall have weathertight housing, resistant to high temperatures and equipped with sun-glare shield and ice preventer. Relays shall be adjusted to switch on lights when the daylight illumination reduces to 70 lux, unless otherwise required by the Engineer.

I. Timers shall be solid-state programmable units with alphanumeric display and have the following features:

1. Astronomic dial.
2. Two contacts, rated 30-A unless otherwise indicated.
3. Two pilot-duty contacts, rated 2-A unless otherwise indicated.

J. Feeder pillars shall have a 50 mm x 6 mm full length high conductivity copper main earth bar for grounding purposes complete with test.

K. A distribution diagram shall be permanently fixed to the inside of the door showing all circuit connections, MCCB ratings, cable sizes and references, etc.

L. Feeder pillars shall be vandal proof and secured against unauthorized access by means of wedge locks protected by brass plugs and operated by a special key as approved by the Engineer or as required by the local authority.

M. Feeder pillars' final finish and final color shall be approved by the Engineer and shall have color similar to that of power distribution boards.

N. Feeder pillars used for external lighting or combined external lighting and power distribution shall have single or multi split bus arrangement as shown on the Drawings with uncontrolled bus section to provide necessary power supply through single pole MCCBs for internal lighting, socket outlets and lighting control system.

O. Feeder pillars used for external lighting shall be provided with compact fluorescent lamp for integrated internal inspection lighting with wire guard and adequate cord length and two weather proof socket outlets type R05 as specified in Division W Section "Surge Protective Devices".

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and Division A Specification Sections, apply to this Section.

210.000 RELATED SECTIONS

A. Division V Section "Basic Electrical Materials and Methods".

B. Division V Section "Surge Protective Devices ".

C. Division W Section "Central Control / Building Management ".

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PART 3 PRODUCTS AND WORKMANSHIP

300.000 MATERIALS

300.010 MANUFACTURERS

A. Approved Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

1. Cutler-Hammer/Eaton Corp.
2. General Electric Co
3. Schneider Electric
4. Siemens - ITE
5. Schneider Electric / Square D Co.
6. ABB

B. Locally assembled products by one of the above approved manufacturers are acceptable subject to compliance with design requirements and adequacy of reference list and quality control of the local factory.

300.020 PRODUCTS

A. Products: Subject to compliance with requirements, provide one of the products indicated for each designation as shown on plans.

310.000 QUALITY MANAGEMENT

310.010 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, and encumbrances to workspace clearance requirements.

310.020 SCHEDULES

A. Schedules shown on drawings indicate the designation and required type of panelboard using the following criteria:

1. Type of construction (MCB or MCCB), referring to type of branch circuit breakers.
2. Voltage, number of phases and wires.
3. Branch circuit breaker trip rating and wire size.
4. Main circuit breaker trip rating and frame size (maximum continuous rating) for MCCB and MCB.
5. Short-circuit interrupting capacity (IC) in kA.
6. Special arrangement or provisions.

310.030 WARRANTY

A. Manufacturer’s Warranty: Submit a written warranty signed by the manufacturer agreeing to repair, restore or replace any defective equipment specified in this section during the specified warranty period

1. Warranty Period: 1 year from date of Substantial Completion.

310.040 FACTORY ACCEPTANCE TEST

A. Factory acceptance tests of equipment under this Contract are subject to be witnessed by the Engineer for locally assembled equipment. Witness test shall include complete routine and function testing on all units to be witnessed. Test procedure and program shall be submitted for approval prior to test conduction. Allow for test expenses including business class transportation and hotel accommodation as necessary for two persons from the Engineer’s/ Employer’s side.

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320.000 SUBMITTALS

A. Equipment Data: Submit data for approval including, but not limited to, the following:

1. Manufacturers' catalogues indicating specific equipment selected.
2. Types of panelboards and circuit breaker characteristics including duties and deration at specified ambient conditions and corresponding temperatures within the enclosures, MCB shall not be derated if the space where the panels are installed is air-conditioned.
3. Dimensions of panels and specific contents of each panelboard.
4. Integrated equipment tabulations for coordinated short- circuit series combinations of circuit breakers.

B. Tests and Certificates: Submit complete certified manufacturer's type test and routine test records in accordance with the Standards.

C. Point-wise compliance statement to the specifications, duly signed by the manufacturer / manufacturer’s authorized representative and the contractor.

D. Shop and Construction Drawings: Submit drawings for approval including, but not limited to, the following:

1. Exact composition of each panelboard, indicating busbar rating, frame and trip ratings of circuit breakers.
2. Typical installation details of panelboards, indicating main feeder and branch circuit conduit connections, terminal provisions, tags, labels, mounting methods and materials used.

E. Coordination Study: Submit coordination study along with setting of protective devices for overload, short-circuit and earth-fault currents as coordinated with upstream and downstream systems based on specific coordination curves of protective devices used and specific calculated prospective short-circuit currents at various points.

F. Details of Electrical Closets: Submit details to verify clearances, spaces and ventilation of the installation of proposed equipment, prior to starting construction.

G. Field Test Reports: Submit written test reports and include the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

H. Panelboard Schedules: For installation in panelboards submit final versions after load balancing.

I. Maintenance Data: For panelboards and components to include in maintenance manuals specified in Division 01 and to the satisfaction of the Employer’s requirements. In addition to requirements specified in Division 01 include the following:

1. Manufacturer's written instructions for testing and adjusting over-current protective devices.
2. Time-current curves, including selectable ranges for each type of over-current protective device.

330.000 EXECUTION

330.010 INSTALLATION

A. Fixing Generally:

1. Align, level and securely fasten panelboards to structure.
2. Fix surface mounted outdoor panelboards at least 25mm from wall ensuring supporting members do not prevent flow of air.
3. Do not use connecting conduits to support panelboards.
4. Close unused openings in panelboard cabinets.

B. Panelboard Interiors: Do not install in cabinets until all conduit connections to cabinet have been completed.

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C. Wiring Inside Panelboards: Neatly arranged, accessible and strapped to prevent tension on circuit breaker terminals. Tap-off connections shall be split and bolted type, fully insulated.

D. Trim: Fix plumb and square prior to painting. Fix trim for flush mounted cabinets flush with wall surface finish.

E. Mounting Heights: Top of trim 1880 mm above finished floor, unless otherwise indicated.

F. Mounting: Plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.

G. Circuit Directory: Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

H. Protection: Treat concealed surfaces of recessed cabinets with heavy field application of waterproof compound prior to installation.

I. Install filler plates in unused spaces.

J. Provision for Future Circuits at Flush Panelboards: if asked by the engineer, stub four empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four empty conduits into raised floor space or below slab not on grade.

330.020 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division V Section "Basic Electrical Materials and Methods".

B. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

330.030 CONNECTIONS

A. Install equipment-grounding connections for panelboards with ground continuity to main electrical ground bus.

B. Tighten electrical connectors and terminals, including screws and bolts, according to manufacturer’s published torque-tightening values and / or recommendations. If manufacturer’s torque values are not indicated, use those specified in applicable Standards.

330.040 FIELD QUALITY CONTROL

A. Generally: Carry out all tests, required by the governing codes and by the Engineer, on panelboards after installation, to verify compliance with the specifications and standards. Inspect conditions within panelboards and verify insulation conditions by use of a megger.

B. Circuit Breakers: Tests shall include operation of every circuit breaker manually. Check automatic operation of selected circuit breakers, as required by Engineer, by applying necessary short-circuit, overload and earth leakage current for tripping circuit breaker as applicable and compare with manufacturer's data/characteristic curves. Measure and report ambient temperature inside enclosure.

C. Insulation Check Tests: Carry out insulation tests on all busbars, between phases and between phases and earth/cabinet, and between neutral and earth. Record all readings, using 500 V megger for equipment on 240 V systems, and 1000 V megger for equipment on systems up to 600 V, for 1-minute, with circuit breakers in open position.

D. Routine tests on site shall be carried out, in accordance with the Standards, on all panelboards assembled from standardized components of the manufacturer outside the works of the manufacturer.

E. Prepare for acceptance tests as follows:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

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F. Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

330.050 CLEANING

A. On completion of installation, inspect interior and exterior of panelboards. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

330.060 ADJUSTING

A. Set field-adjustable switches and circuit breaker trip ranges.

330.070 DEMONSTRATION AND TRAINING

A. Train Employer's maintenance personnel to adjust, operate, and maintain the system installation. Refer to Division A Section "Demonstration and Training and Closeout Procedures."

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Y75 - POWER FACTOR CORRECTION CAPACITORS

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. This Section includes automatic power factor correction equipment rated 600 V and less.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Comply with the following Standards:

1. IEC 60831-1&-2, and IEC 60931-1&-2.
2. IEC 61921.
3. IEC 61439.
4. IEC 60076-6.

120.000 SYSTEM DESCRIPTION

120.010 CAPACITORS, GENERAL

A. Construction: Multiple capacitor cells or elements, factory wired in three-phase groups and mounted in metal enclosures.

B. Capacitor Cells: Dry, metallized-dielectric, self-healing type. Each cell shall be encapsulated in thermosetting resin inside plastic container.

C. Capacitors shall comply with IEC 60831, with an internal loss factor not exceeding 0.5 x 10(-3) (a consumption of about 0.5 watts per kVAR).

D. Cell Rupture Protection: Pressure-sensitive circuit interrupter for each cell.

E. Capacitor-Bank Fuses: Current limiting, non-interchangeable type; factory installed in each phase and located within the equipment enclosure. Features include the following:

1. Interrupting Capacity: 120,000 A, minimum.
2. Fuse Ratings and Characteristics: As recommended by capacitor manufacturer.
3. Fuses shall be provided with a monitoring facility for an immediate tripping after any fuse is blown to prevent single phasing. The monitoring shall reset automatically after the replacement of the blown fuse(s).
4. Neon Indicator Lamp for Each Fuse: Connect to illuminate when fuse has opened, but is still in place, and locate so it is visible from outside the enclosure.

F. Discharge Resistors: Factory installed and wired.

G. Enclosure: Steel or aluminum, arranged to contain the fluid leakage from capacitor cells; factory equipped with mounting brackets suitable for type of mounting indicated. Wherever the capacitor bank is part of the main distribution board and interconnected internally with busbars, the enclosure shall be of the same construction as the approved main distribution board. Enclosure types shall be as follows:

1. Indoor Enclosures: IP 21 to IEC 60529 or as indicated.
2. Outdoor Enclosures: IP 54 to IEC 60529, equipped with watertight conduit connections.

H. Anti Harmonic Reactors shall be provided in series with the capacitors and properly tuned to limit the harmonic currents in order to avoid over loading the capacitors. The reactor rating shall not exceed 7% of the capacitors to be protected.

I. Capacitor rating voltage shall not be less than 470 V at design indicated kVAR rating.

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120.020 AUTOMATIC POWER FACTOR CORRECTION UNITS

A. Comply with IEC 60831-1,2 and IEC 60931-1,2.

B. Description: Capacitor banks, contactors, controls, and accessories factory installed as indicated on drawings and as close as possible to/or within nominated switchboard requiring PF improvement. Units include a separately mounted current transformer to sense current in the power circuit being corrected and to provide input to unit controls.

C. Performance Requirements: Controls permit selection of a target power factor, adjustable to any value between 0.92 and 0.80 lagging. Controls continuously sense the power factor on circuits being corrected and, when the power factor differs from the target setting for more than 10 seconds, operate a contractor to switch a capacitor bank into or out of the circuit. Contactors are opened or closed as required to bring the corrected circuit power factor closer to the target setting. Switch only one capacitor bank at a time.

D. Controls: Solid-state, microprocessor-based controls, including the following:

1. Undervoltage relay that interrupts capacitor switching and disconnects capacitors for power supply interruptions longer than 15 minutes.
2. "Advance" and "Retard" push buttons on the control panel to permit manually controlled capacitor-bank switching.

E. Contactors: Three pole; rated for the repetitive high-inrush-switching duty in the capacitor application.

F. Buses: Plated copper.

G. Fuses for Protection of Capacitor Banks: Rated to protect contactor, interconnecting wiring, and capacitors.

H. Inductors: Iron-core-type, connected in capacitor circuits; rated to limit switching surges to within contactor ratings.

I. Mechanical Bracing for Current-Carrying Parts: Adequate to withstand the maximum fault current to which they may be exposed.

J. Identification of Energized Capacitor Banks: LED indicating lamps on front panel.

K. Enclosure Access: Hinged door with hand-operated catch. Door is interlocked with controls or main circuit breaker to de-energize capacitors when door is opened.

L. Local Display: LED or liquid-crystal digital type, mounted in door of enclosure.

1. Indicated target and actual power factors.
2. Accuracy: Plus or minus 1 percent.
3. Mounting: Flush or semiflush in unit door.

M. Current Transformer: Type, configuration, and ratio to suit sensing and mounting conditions.

N. Main Circuit Breaker: Operable from outside the enclosure to disconnect the unit.

1. Operating handle can be padlocked.

O. Remote Monitoring Components: Sensors, associated communication modules, and network interface units, matched to and compatible with BMS. Communication module transmits data to remote monitoring devices. Data includes actual corrected power factor.

120.030 FACTORY FINISH

A. Manufacturer's standard enamel over corrosion-resistant treatment or primer coat.

120.040 SOURCE QUALITY CONTROL

A. Factory test power factor correction equipment before shipment. Comply with IEC 60831-1,2 and IEC 60931-1,2 . Include the following:

1. Routine capacitor production tests, including short-time overvoltage, capacitance, leak, and dissipation-factor tests.

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2. Functional test of all operations, controls, indicators, sensors, and protective devices.

PART 1 REFERENCES

100.000 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and Division 01 Specification Sections, apply to this Section.

110.000 RELATED SECTIONS

A. Division V Section "Basic Electrical Materials and Methods".

PART 2 PRODUCTS AND WORKMANSHIP

200.000 MATERIALS

200.010 MANUFACTURERS

A. Approved Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

1. Schneider Electric.
2. Schneider Electric / Square D.
3. ABB
4. Siemens
5. General Electric Co.; Business Information Center
6. Eaton

200.020 PRODUCTS

A. Products: Subject to compliance with requirements, provide one of the products indicated for each designation as shown on plans.

210.000 QUALITY MANAGEMENT

210.010 QUALITY ASSURANCE

A. Compliance with Local Requirements: Comply with applicable local regulations/code requirements of ENDE and Authorities having jurisdiction. This will have precedence over other Codes/Standards nominated for the project, unless otherwise approved in writing.

210.020 COORDINATION

A. Coordinate power factor automatic regulator communication module with BMS data network and with monitoring equipment specified in Division W Section "Central Control / Building Management" for successful transmission and remote readout of remote monitoring data specified in this Section.

210.030 WARRANTY

A. Manufacturer’s Warranty: Submit a written warranty signed by the manufacturer agreeing to repair, restore or replace any defective equipment specified in this section during the specified warranty period

1. Warranty Period: 1 year from date of Substantial Completion.

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210.040 SPARE PARTS AND EXTRA MATERIAL

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to Employer.

   1. Fuses: 1 for every step of each type and rating, but not less than 3 of each.

220.000 SUBMITTALS

A. Product Data: For each type of product indicated. Include dimensions; shipping, installed, and operating weights of multiple capacitor cells or elements; and data on features, ratings, and performance.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, method of field assembly, components, and location and size of each field connection. Show access and workspace requirements and required clearances.

   1. Wiring Diagrams: Detail internal and interconnecting wiring and differentiate between manufacturer-installed and field-installed wiring.

C. Point-wise compliance statement to the specifications, duly signed by the manufacturer/ manufacture's authorized representative and the Contractor.

D. Power factor correction calculations based on the available network data and the expected load requirements for final selection of capacitor bank among steps and the associated detuned reactor.

E. Factory Test Reports: Evidence of product's compliance with specified requirements.

F. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

G. Maintenance Data: For equipment to include in maintenance manuals specified in Division 01. Include the following:

   1. Lists of spare parts and replacement components recommended for storage at Project site.
   2. Detailed instructions covering operation under both normal and abnormal conditions.

230.000 EXECUTION

230.010 INSTALLATION

A. Install freestanding equipment on concrete bases. Cast-in-place concrete is specified in Division 3.

B. Maintain minimum workspace according to manufacturer's written instructions.

C. Connect remote monitoring communication module to electrical power monitoring and control data network through appropriate network interface unit.

230.020 IDENTIFICATION

A. Identify components according to Division V Section "Basic Electrical Materials and Methods."

230.030 FIELD QUALITY CONTROL

A. Inspect automatic power factor correction equipment installation and connections. Report results in writing. Include the following:

   1. Operational Test: After electrical circuits have been energized, connect and observe units to confirm proper operation.
   2. Replace damaged and malfunctioning controls and equipment.

B. Inspection: Perform external and internal inspections of capacitor equipment for damage and for compliance with the Contract Documents and manufacturer's documentation. Check electrical and mechanical bolted connections for required torquing.

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C. Testing: Perform the following and certify compliance with test parameters:

1. Test insulation resistance between capacitor terminals and case. Follow manufacturer's written instructions or those below:

a) Use test voltages 500 V minimum, for equipment rated 250 V and less, and 1000 V minimum, for equipment rated more than 250 V.
b) Apply test voltage for 60 seconds.
c) Investigate, report, and resolve insulation resistance less than that stated by manufacturer's literature or less than allowable 25 megohms for equipment rated 250 V and less and 100 megohms for equipment rated more than 250 V.
d) Measure capacitance of pole-to-pole capacitor combinations and compare with manufacturer's published values. Report readings, and investigate and resolve discrepancies more than 10 percent of manufacturer's nominal values.
e) Energize circuits and demonstrate electrical operating features of automatic power factor correction units according to manufacturer's written instructions.
f) Verify accuracy of remotely monitored parameters transmitted from automatic power factor correction units by communication module.

D. Correct deficiencies shown by inspections and tests on site where possible, and retest; otherwise, remove and replace with new units and retest.

E. Report of Tests and Inspections: Written record including adjustment settings.

230.040 CLEANING

A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean components internally, on completion of installation, according to manufacturer's written instructions.

230.050 ADJUSTING

A. Adjust for optimum automatic power factor correction.

230.060 DEMONSTRATION AND TRAINING

A. Train Employer's maintenance personnel to adjust, operate, and maintain the system installation. Refer to Division A Section "Demonstration and Training and Closeout Procedures."

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Y76 - TRANSFER SWITCHES

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:

1. Automatic transfer switch with bypass.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Comply with IEC 60947-6.

120.000 SYSTEM DESCRIPTION

120.010 MAINS FAILURE AUTOMATIC TRANSFER SWITCH (ATS)

A. Type: Conforming to IEC 60947-6 and to applicable standards, capable of frequently switching mixed motors and resistive loads with utilization category AC33A to IEC 60947-6-1 or equivalent. Wall or floor mounted, galvanized sheet steel cubicle of equal construction to control cubicle, comprising switching and controls necessary for automatic transfer of power supply from normal source to stand-by source, voltage sensing control relay and time delay relays to signal generator start and stop, auxiliary switches and indicating lights etc. as necessary for the required operation of the system.

B. ATS fed main distribution board / distribution panel shall be class PC with double throw single switch and having rated short time withstand and short circuit making current to IEC 60947-6-1, based on short circuit level of the network at equipment location. As an alternative, two single throw contactors ATS may be used subject to Engineer's approval if obtained from a reputable manufacturer and fulfils the test requirements of class PC to IEC 60947-6-1.

C. ATS fed directly from transformer shall be class CB with two single throw circuit breakers and having rated short time withstand and short circuit making and breaking current to IEC 60947-6-1, based on short circuit level of the network at equipment location.

D. Operation: When voltage and/or frequency of any phase drops below an adjustable setting (80-100%) of normal supply, for an adjustable period of 1 - 300 seconds, power failure relay shall actuate engine starting control. After an adjustable period of 0 - 10 seconds from sensing stabilized rated voltage and frequency of generator at the ATS, (Voltage pick-up adjustable from 85% to 100% nominal), frequency pick-up adjustable from 90% to 100% nominal, the ATS shall transfer to the emergency position. Upon restoration of normal mains supply to above the preset limits, adjustable between 90% and 100% of rated voltage and/or frequency, for an adjustable preset period of 2 - 30 minutes, the ATS shall transfer the load to normal position.

E. Engine Shutdown: Initiate after retransfer of the load to normal source. (Refer to generator set controls upon shut-down).

F. Mechanical and Electrical Interlocks: shall be provided in C.B. type ATS to prevent circuit breakers from being closed simultaneously at any time. Transfer mechanism shall be powered from the source to which the load is being transferred.

G. Utility to utility or two energized sources ATS shall automatically operate as described in clause 120.010 D above except that no generator start signal is required. The ATS shall be provided with a preferred source selector switch marked "source 1", "source 2".

H. ATS dedicated for fire pumps shall meet the requirement of NFPA 20, "Installation of Central Fire Pumps", NFPA 70, "National Electrical Code", listed by the Underwriter Laboratories UL 1008,

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"Transfer Switch Equipment" for use with electric driven fire pumps, FM approved and shall be as specified under Division Y Section "Pumps".

I. Selector Switches shall be provided as follows:

1. Operating selector switch shall include the following positions:

a) Normal: Generator set is set for automatic operation and the generator set starts if a power outage occurs, as described above.
b) Test: Stimulates a power outage, starts and runs the generating set as Normal position.
c) Stop: Shuts down the generating set and prevents it from starting. This is used when servicing the generator.

2. Another selector switch shall be provided for two positions, "With load" and "Without load" for testing or exercising:

a) "With Load": the generating set shall carry the load during testing or exercising periods.
b) "Without Load": generating set shall start but not assume the load.

J. Pilot Lights shall indicate all ATS positions and sources available.

K. Instruments shall include voltmeter and ammeter with selector switches.

L. Automatic Retransfer: automatic retransfer selector switch marked "AUTO", "MANUAL" shall be provided. On manual position, automatic retransfer is disabled, while it is enabled in the auto position.

M. Circuit Breakers shall be electrically and manually operated non-automatic type, conforming to IEC 60947-2 utilization category B, sequence II (service rating), with two N.O and two N.C spare contacts each.

N. Degree of Protection: ATS shall have an IP31 degree of protection to IEC 60529 for indoor installations, IP54 degree of protection for installations in wet areas and for ATS serving life safety and firefighting equipment and IP55 degree of protection for outdoor installations.

O. Wiring: Moisture and heat resistant, silicon rubber insulated, stranded copper conductors, modularly and neatly arranged on master terminal blocks, with suitable numbering strips and appropriate cartridge type fuses where required. Flexible wiring shall be used on all hinged/draw-out components.

P. Connections shall be made at front insulating terminal blocks with no live metal exposed. Power cables shall terminate on fixed insulated copper connectors suitably sized to receive specified cables. Cable glands and gland plates shall be provided.

Q. Metal Cases of instruments, control switches, relays etc. shall be connected by flexible protective conductors, of not less than 2.5 mm2 section, to nearest earthing bar or terminal.

R. Earthing: Earthing bar shall be provided for connection of protective earthing conductors, using set-screw or bolted anti-turn pressure terminations.

S. Ferrules: Wire ends shall be fitted with numbered ferrules of approved type at each termination.

T. All automatic transfer switches fed directly from transformer shall be equipped at the utility incomer with class I+II surge protective devices as specified under Division W Section " Surge Protective Devices ". SPDs along with their fused-disconnect switch shall be integrated within the ATS's enclosure.

U. All automatic transfer switches fed main distribution board / distribution panel shall be equipped at the utility incomer with class II surge protective devices as specified under Division W Section "Surge Protective Devices ". SPDs along with their fused-disconnect switch shall be integrated within the ATS's enclosure.

V. Provide Manual Bypass Switches to combine manual and automatic transfer operation with a drawout isolation system. Bypass switch shall consist of non-automatic Kirk-key interlocked switches or circuit breakers, fully rated, manually operated and rated for same loads as automatic transfer switch.

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W. Bypass switch shall provide bypass to either normal or emergency source by use of a selector switch and a permanently mounted external lever, mechanically interlocked to prevent paralleling of sources.

X. An engine start switch shall be provided to allow generator set to be started when bypass is on emergency sources.

Y. Bypass switch shall be of the make-before-break type. A dead source lockout shall prevent any possibility of bypassing the load to an unenergized source.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

1. Drawings and general provisions of the Contract, including Conditions of Contract and Division A Specification Sections, apply to this Section.

210.000 RELATED SECTIONS

A. Section Y20 " Pumps" for automatic transfer switches for fire pumps.

B. Section V0 "Basic Electrical Materials and Methods".

C. Section Y71A "Switchboards" for circuit breakers.

D. Section W57 "Surge Protection Devices".

E. Section W60 " Central Control / Building Management ".

PART 3 PRODUCTS AND WORKMANSHIP

300.000 MATERIALS

300.010 MANUFACTURERS

A. Approved Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

1. Asco/Emerson Electric
2. Caterpillar, Inc.; Engine Division.
3. Cummins Corp.
4. Schneider Electric / Square D
5. Kohler Co.
6. Russelectric, Inc.
7. GE/Zenith Controls, Inc.
8. Cutler-Hammer/Eaton Corp.
9. GE/Zenith Controls, Inc.

B. Locally assembled transfer switches meeting the Specification are not acceptable.

300.020 PRODUCTS

A. Products: Subject to compliance with requirements, provide one of the products indicated for each designation as shown on plans.

310.000 QUALITY MANAGEMENT

310.010 QUALITY ASSURANCE

A. Local Representative: Provide evidence that proposed equipment manufacturer has a locally established and authorized organization which can be called upon for professional advice and maintenance as may be required, and which can immediately supply spare parts to support day to day and emergency maintenance requirements. Failure to satisfy the Engineer may disqualify a manufacturer.

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B. Source Limitations: Obtain automatic transfer switch, bypass/isolation switch and related control panels through one source from a single manufacturer.

310.020 WARRANTY

A. Manufacturer's Warranty: Submit a written warranty signed by the manufacturer agreeing to repair, restore or replace any defective equipment specified in this section during the specified warranty period

1. Warranty Period: 1 year from date of Substantial Completion.

320.000 SUBMITTALS

A. Technical Data: Include ratings and dimensioned plans, sections, and elevations showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

B. Wiring Diagrams: Detail wiring for transfer switches and differentiate between manufacturer-installed and field-installed wiring. Show both power and control wiring.

C. Point-wise compliance statement to the specifications, duly signed by the manufacturer / manufacturer's authorized representative and the contractor.

D. Single-Line Diagram: Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch.

E. Product Certificates: Signed by manufacturer certifying that products furnished comply with requirements and that switches have been tested for load ratings and short-circuit closing and withstand ratings applicable to units for Project.

F. Field Test Reports: Indicate and interpret test and inspection results for compliance with performance requirements.

G. Maintenance Data: For each type of product to include in maintenance manuals specified in Division 01 and to the satisfaction of the Employer's requirements. Include all features and operating sequences, both automatic and manual. List all factory settings of relays and provide relay setting and calibration instructions, including software, where applicable.

330.000 EXECUTION

330.010 INSTALLATION

A. Floor-Mounted Switch: Level and anchor unit to floor.

B. Identify components according to Division V Section "Basic Electrical Materials and Methods."

330.020 WIRING TO REMOTE COMPONENTS

A. Match type and number of cables and conductors to control and communications requirements of transfer switches as recommended by the manufacturer. Increase raceway sizes at no additional cost to Employer if necessary to accommodate required wiring.

330.030 CONNECTIONS

A. Ground equipment as indicated and as required by the Standards.

330.040 FIELD QUALITY CONTROL

A. Testing: Perform the following field quality-control testing in addition to tests recommended by the manufacturer:

1. Before energizing equipment, after transfer-switch products have been installed:

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a) Measure insulation resistance phase-to phase and phase-to-ground with insulation-resistance tester. Include control circuits. Use test voltages and procedure recommended by manufacturer. Meet manufacturer's specified minimum resistance.
b) Check for electrical continuity of circuits and for short circuits.
c) Inspect For:
d) Physical damage.
e) Proper installation and connection
f) Integrity of barriers, covers, and safety features.
g) Verify that manual transfer warnings are properly placed.
h) Perform manual transfer operation.

2. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

a) Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
b) Verify time-delay settings.
c) Verify pickup and dropout voltages by data readout or inspection of control settings.
d) Test bypass/isolation unit functional modes and related automatic transfer-switch operations.
e) Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown sequence.

B. Coordinate tests with tests of generator plant and run them concurrently.

C. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

330.050 CLEANING

A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean equipment internally, on completion of installation, according to manufacturer's written instructions.

330.060 DEMONSTRATION AND TRAINING

A. Train Employer's maintenance personnel to adjust, operate, and maintain the system installation. Refer to Division A Section "Demonstration and Training and Closeout Procedures."

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Y80 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. This Section includes complete installations to earth every source of energy and to provide protective earthing and equipotential bonding, based on the TN-S system arrangement, including:

1. Transformer neutral earthing.
2. Main earthing terminals or bars.
3. Exposed conductive parts of electrical equipment.
4. Extraneous conductive parts.
5. Generator neutral earthing.

Earthing requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

110.000 DESIGN PARAMETERS

110.010 DEFINITIONS AND ABBREVIATIONS

A. The following terms used on the Drawings and in the Specification are equivalent and may be used interchangeably: "earth" and "ground"; "earthing" and "grounding".

B. Earth: Conductive mass of the Earth whose electric potential at any point is conventionally taken as zero.

C. Earth Electrode: Conductor or group of conductors in initial contact with, and providing electrical connection to, Earth.

D. Exposed Conductive Part: Any part which can be readily touched and which is not a live part, but which may become live under fault conditions.

E. Extraneous Conductive Part: Any conductive part not forming part of the electrical installation such as structural metalwork of a building, metallic gas pipes, water pipes, heating tubes etc. and non-electrical apparatus electrically connected to them i.e. radiators, cooking ranges, metal sinks etc. and non-insulating floors and walls.

F. Protective Conductor: Conductor used for some measure of protection against electric shock and intended for connecting together any of the following parts:

1. Exposed conductive parts.
2. Extraneous conductive parts.
3. Earth electrode(s).
4. Main earthing terminal or bar(s).
5. Earthed point of the source(s).
6. Samples of conductors connectors, or any other accessories as requested by the engineers.

G. Electrically Independent Earth Electrodes: Earth electrodes located at such distance from one another that maximum current likely to flow through one of them does not significantly affect the potential of the other(s).

H. Main Earthing Terminal or Bar: The terminal or bar provided for the connection of protective conductors, including equipotential bonding and functional earthing conductors if any to the means of earthing.

I. Equipotential Bonding: Electrical connection to put exposed and extraneous conductive parts at a substantially equal potential.

J. Earthing Conductor: Protective conductor connecting main earthing terminal or bar of an installation to earth electrode or to other means of earthing.

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110.020 REFERENCE STANDARDS

A. Standards: Carry out work in accordance with the following:

1. IEC 60364-1, IEC 60364-51, IEC 60364-5-55 and IEC 60364-4-41: Electrical Installations in Buildings.
2. Latest edition of the IET Wiring Regulations, BS 7671.
3. BS 7430: Code of Practice for Earthing.
4. TIA J-STD-607-A: Commercial Building Grounding and Bonding Requirements for Telecommunications.

B. Comply with IEC 62305 when interconnecting with lightning protection system.

120.000 SYSTEM DESCRIPTION

120.010 GENERAL REQUIREMENTS

A. Component parts of earthing system are to include the following:

1. Earth electrode (rods, tapes etc.)
2. Main earthing terminals or bars.
3. Earthing conductors.
4. Protective conductors.
5. Equipotential bonding conductors.
6. Electrically independent earth electrodes for special systems.
7. Accessories and termination fittings, bonding, welding kits and other materials.

B. Provide a common earth termination network for all services, consisting of bonding earthing networks of all individual services. The resistance to earth should, in this case be the lowest value needed for any of the individual services. Combined resistance to ground of the whole network is not to exceed 1 Ohms.

C. Ground Electrode: Provide one or a combination of the following arrangements as necessary and/or shown on the drawings:

1. Earth electrode is to consist of one or more earth rods, interconnected by buried earthing tape or cable; distance between two rods is not to be less than twice the length of one rod driven depth.
2. Ring type earth electrode consisting of earthing conductors, in a closed loop, buried in exterior wall foundations underneath the water-proofing, or alternatively buried at a depth of 0.5 m and a distance of about 1 m around external walls, or as shown on the Drawings. Connect all earthing conductors to this ring. Insulated connection flags into the building, of same material as earthing conductors, at locations specified in point (F) underneath are to terminate into bolt-type earth points (studs) or test- links for connection of main earth bar(s). Additional earth rods connecting with the earth ring are to be provided, as necessary, to bring down earth electrode resistance to the specified value.
3. Alternative Earth Electrode: other types of earth electrode may be used, after approval, including:

a) Cast iron pipes with special surround material
b) Copper plate(s)
c) Tape mats (strips).

D. Main earthing bar is to be provided at point of service entrance or medium voltage, transformer, generator, low voltage, low current, and mechanical distribution rooms; as described in the Specification or shown on the Drawings. Connect all earthing conductors, protective conductors and bonding conductors to the main earthing bar. Provide two insulated main earthing conductors, one at each end of the bar, connected via testing joints to the earth electrode at two separate earth pits. Conductor is to be sized to carry maximum earth fault current of system at point of application with final conductor temperature not exceeding 160 deg. C for at 1 second for medium voltage systems and 0.4 seconds for low voltage systems. Main earthing conductors are to be minimum 120 mm2 or as shown on drawings.

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E. Testing joints (test links) are to be provided, in an accessible position, on each main earthing conductor, between earthing terminal or bar and earth electrode.

F. Protective conductors are to be separate for each circuit. Where protective conductor is common to several circuits, cross-sectional area of protective conductor is to be the largest of the conductor sizes.

1. Selection of sizes is to be in accordance with Table 54.7 of IET Wiring Regulations (BS 7671).

G. Protective conductors are not to be formed by conduit, trunking, ducting or the like. Where armored cable is specified and armor is steel, it may be used as a protective conductor, if approved and if not otherwise shown on the Drawings.

H. Continuity of Protective Conductors: Series connection of protective conductor from one piece of equipment to another is not permitted. Extraneous and exposed conductive parts of equipment are not to be used as protective conductors, but are to be connected by bolted clamp type connectors and/or brazing to continuous protective conductors which are to be insulated by molded materials.

I. Ensure by calculation that Earth Fault Loop Impedance values for final circuits are to satisfy the requirements of BS 7671 regulations.

J. Supplementary Equipotential Bonding: Connect all extraneous conductive parts of the building such as metallic water pipes, drain pipes, other service pipes and ducting, metallic conduit and raceways, cable trays and cable armor to nearest earthing terminals by equipotential bonding conductors. Cross-section of protective bonding conductor shall not be less than half of the protective conductor connected to respective earthing terminal with a minimum of 4-mm2.

K. Main Equipotential Bonding: Main incoming and outgoing water pipes and any other metallic service pipes are to be connected by main equipotential bonding conductors to main earth terminal or bar. Bonding connections are to be as short as practicable between point of entry/exit of services and main earthing bar. Where meters are installed, bonding is to be made on the premise side of the meter. Cross-sections of conductors are not to be less than half that of the earthing conductor connected thereto, and minimum 6 mm2.

L. Identification: Connection of every earthing conductor to earthing electrode and every bonding conductor to extraneous conducting parts is to be labeled in accordance with the Regulations, as follows:

1. SAFETY ELECTRICAL CONNECTION - DO NOT REMOVE.

M. Identification: Protective and earthing conductors are to be identified by combination of green-and-yellow colors of insulation or by painting bar conductors with these colors, as approved.

N. Identification: Source earthing conductor (or neutral earthing conductor) is to be identified along its entire length by continuous black insulation labeled 'neutral earthing'.

120.020 GROUNDING CONDUCTORS

A. Buried Earth Conductors: Bare annealed copper strip conductors 30 x 4 mm, or annealed stranded copper conductors 120 mm2 cross-section, unless otherwise indicated on drawings.

B. Earthing Conductors: Insulated or bare copper conductor as described in 2.2 (F).

C. Protective Conductors: Single core stranded annealed copper, PVC insulated cables, having rated insulation grade compatible with circuit protected, or to be a conductor forming part of a multi-core cable, color coded.

D. Protective Bonding Conductors: Bare copper strip conductor, annealed stranded copper cable or flexible strap (flexible braid) of cross-sectional area as described in Article "General Requirements" hereof.

E. Power Systems (transformer, medium voltage switchgear, generator, and main distribution board) Main Earthing Bar: Consisting of hard drawn copper bar, 50 x 6 mm, unless otherwise indicated on drawings. Earth bar is to be labeled 'Main Earth Bar' and is to be drilled, for connection of conductors, at a spacing not less than 75 mm, and is to be supplied with copper alloy bolts, nuts and washers and wall mounting insulators.

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F. Telecommunication Systems Main Earthing Bar: similar to above but with minimum dimensions 100 x 6 mm for the main grounding busbar of the main telecommunication room, and 50 x6 mm for equipment rooms grounding busbars.

120.030 CONNECTOR PRODUCTS AND EARTHING ACCESSORIES

A. Copper or copper alloy, purpose made, of approved design, compatible with points of connection, and of adequate cross-section and current carrying capacity.

B. Bolted Connectors and Clamps: Bolted-pressure-type connectors and clamps, or compression type. Bolts, nuts and washers are to be high quality phosphor bronze or copper silicon alloys.

C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

120.040 GROUNDING ELECTRODES

A. Ground Rod: 16-mm diameter high strength, low carbon steel core of high tensile strength (600 N/mm2), with 99.99% pure electrolytic copper molecularly bonded into steel core, 0.25 mm minimum thickness. Driving head is to be high strength steel. Couplings are to be long length silicon bronze, internally threaded. Threads are to be rolled onto rod to ensure uniform layers of copper and strength. Earth rod is to be complete with couplings, head and bolted connector of sufficient size, and number of bolted clamps to connect all cables terminated thereto.

1. Minimum Length of Rod: 2.5 m, extendible as necessary to obtain required earth resistance.

B. Earth Pit: Precast, square or circular section concrete handhole (minimum 450 mm internal diameter), with concrete cover, and extending to about 150 mm below top of earth rod. Earth pit is to be provided for each earth rod where connected to an earthing conductor. Cover is to have inset brass plate with inscription 'Earth Pit - Do Not Remove'.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and Division A Specification Sections, apply to this Section.

210.000 RELATED SECTIONS

A. Division Y Section "Underground Ducts and Raceways for Electrical Systems" for ground earth pits.

B. Division W Section “Lightning Protection for Structures" for additional grounding and bonding materials.

C. Division V Section "Basic Electrical Materials and Methods".

D. Division Y Section “Low Voltage Electrical Power Conductors and Cables ".

PART 3 PRODUCTS AND WORKMANSHIP

300.000 MATERIALS

300.010 MANUFACTURERS

A. Approved Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

1. BICC
2. Copperweld
3. Furse
4. Wallis

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300.020 PRODUCTS

A. Products: Subject to compliance with requirements, provide one of the products indicated for each designation as shown on plans.

310.000 QUALITY MANAGEMENT

310.010 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced installer who has specialized in installing earthing systems similar in material, design and extent to those indicated for this Project and whose work has resulted in installations with a record of successful in-service performance.

320.000 SUBMITTALS

A. Product Data: Prior to ordering materials, submit data for approval including, but not limited to, manufacturer's catalogues for each type of product indicated including the following:

1. Ground rods.
2. Connecting clamps.
3. Earthing conductors, protective conductors, and bonding conductors.
4. Connectors and other accessories.
5. Exothermic welding kits and tools.

B. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects/engineers and owners, and other information specified or required by Engineer.

1. Field Test Reports: Submit written test reports to include the following:

1) Test procedures used and test conditions.
2) Test results that comply with requirements.
3) Results of failed tests and corrective action taken to achieve test results that comply with requirements.

C. Shop and Construction Drawings: Submit drawings for approval including, but not limited to, the following:

1. Exact location of earth pits, rods and details of installation and connections.
2. Exact routing of buried earthing conductors with indication of cross-section, depth of laying and covering.
3. Cross sectional area of all earthing, protective and bonding conductors.
4. Layout and details of earthing provisions at substations, generator rooms, switchgear, distribution panelboards etc., indicating fittings used, insulation, plates and marking, passage and routing of earthing conductors, conduit, sleeves, grooves, niches etc., giving sizes and dimensions of component parts.

D. Records: Submit the following:

1. Scaled drawings, as-installed, showing actual layout and specification of all components of earthing system.
2. Nature of soil and any special earth arrangements etc.
3. Date and particulars of soil conditioning method and agents if used.

E. Samples: Submit samples of conductors, as requested by Engineer.

330.000 EXECUTION

330.010 TRANSFORMER SUBSTATION EARTHING

A. Medium Voltage (MV) switchgear is to have a separate main earthing bar connected to MV switchgear room earth bar by two insulated earthing conductors not less than 120mm2 for LSC2A type switchgear, and 120mm2 for LSC2B, unless otherwise shown on drawings.

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B. LV switchgear (main distribution board) is to have separate main earthing bar connected to LV room earth bar by two insulated earthing conductors not less than 120 mm2, unless otherwise shown on drawings.

C. Transformer room is to have a separate MV main earthing bar, to which the transformer earthing terminal is to be connected by insulated copper earthing conductor not less than 120mm2, unless otherwise shown on drawings.

D. Transformer neutral (star point) is to be connected by insulated earthing conductor (color black) to transformer room MV main earthing bar. Neutral earthing conductor is to be sized for maximum earth fault current for 1 second with final conductor temperature not exceeding 160 deg. C or sized not less than 120 mm^2 for transformer ratings below 500 kVA and 300 mm^2 for higher ratings unless otherwise indicated on drawings. Where a neutral is directly connected to earth electrode, an insulated disconnecting device is to be provided at the transformer.

E. Lightning arresters are to be directly connected to earth electrode, following the shortest path. Each lightning arrester is to be connected at a dedicated earth rod, unless otherwise shown on drawings.

330.020 EARTHING OF MAIN DISTRIBUTION BOARDS, PANELBOARDS, LIGHTING INSTALLATIONS AND WIRING ACCESSORIES

A. For earthing of main distribution boards, refer to item 3.1 (C).

B. Distribution, lighting and power panelboards are to be connected by protective conductors run together with incoming feeder cable, connecting earth terminals in panelboards with respective main distribution board earthing bar.

C. Socket outlets are to be earthed by protective conductor looped around with the branch circuit and connected to earth terminal within socket outlet box and to which socket outlet terminal is to be connected.

D. Final Ring Sub-Circuits: Protective conductor of every final ring sub-circuit is to be in the form of a ring having both ends connected to earth terminal at origin of circuit in panelboard.

E. Lighting fixtures and other exposed conductive parts of electrical installations, such as switches, heaters, air conditioning units etc. are to be connected by protective earth conductors to earthing terminals of respective panelboards.

330.030 GENERATOR PLANT EARTHING

A. Generator room is to have a separate main earthing bar, to which the generator neutral (star point) is to be connected by insulated earthing conductor through the neutral earthing link or device. Neutral earthing conductor is to be suitably sized to carry maximum earth fault current for time it takes the system protection to operate with final conductor temperature not exceeding 160 deg. C, but not less than 120 mm2 for generator ratings below 500 kVA and 300 mm2 for higher ratings, unless otherwise shown on the drawings.

B. Generator earthing terminal is to be connected to the generator room main earthing bar by insulated copper conductor of cross section not less than 120 mm2, unless otherwise shown on the drawings.

C. Switchgear (ATS) and Control Gear: Earthing terminals or bars of switchgear and control gear are to be connected by separate protective conductors to respective normal and emergency main distribution board earth bars.

D. Extraneous conductive parts including steel frames, battery racks, day-tank, pumps and piping are to be connected by bare copper earthing conductors to main earth bar in compliance with bonding regulations.

330.040 MECHANICAL PLANT ROOMS AND FIXED MACHINERY

A. Mechanical room is to have separate earthing bar(s) or loop conveniently located, and connected by earthing conductors to exposed conductive parts of motor control centre at its earthing bar, and to motors, switches and other electrical equipment etc. at their earthing terminals, using copper conductor with half size of the protective earth conductor and not less than 6 mm^2, , unless otherwise indicated on drawings. Conductors are to be securely fixed, recessed in floor grooves or niches, or

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fixed to walls by appropriate staples. Earth bar or loop is to be securely fixed to building wall with copper or brass saddles.

B. Earthing bar (40 x 4 mm) is to be connected by two insulated earthing conductors, one at each end of the bar, through testing joints to the earth electrode at two separate earth pits, or to the main LV earth bar. Earthing conductors are to be minimum 70 mm2 or as shown on drawings.

C. Motor and other equipment earth terminals are to be connected also by protective earth conductors of each branch circuit to earth terminal/bar at motor control centre, panel or distribution unit.

330.050 ROAD LIGHTING

A. Earthing Cables: separate protective earthing cables for lighting column circuits are to be run with power circuit, terminated at LV supply position in lighting control panel and looped into column earthing terminals. The last column is to be bonded via an earthing bolt to a single 14 mm diameter copper covered steel rod, 2.5 m long, driven into ground adjacent to column. Bonding is to be 16 mm2 stranded bare copper conductor, unless otherwise indicated on drawings.

B. Connections between rods and earthing conductors are to be made by the Cadweld process producing a fused joint. Bolted connections may be used for connection to removable items of equipment only.

330.060 SIGNAL AND COMMUNICATION SYSTEMS

A. Signal and communication systems room is to have separate earthing bar conveniently located, and connected by two insulated earthing conductors, one at each end of the bar, through testing joints to the earth electrode at two separate earth pits, or to the main LV earth bar. Earthing conductors are to be minimum 70 mm2 or as shown on drawings.

B. For telephone, alarm, voice and data, and other communication systems, provide 16mm2 minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location, unless otherwise indicated on drawings or recommended by system provider.

330.070 INSTALLATION

A. Continuity: Ensure that complete earthing system is electrically continuous and mechanically secure.

B. Earth Rods: While siting earth rods, ensure that resistance areas associated with individual rods do not overlap. Earth rods are to be located at a distance greater than 1 m horizontally from foundations of buildings. Where rock is encountered, a hole of sufficient size is to be drilled before lowering the rod. Conductive filler such as Marconite or Bentonite or equal filler that will not corrode, is to be provided around the rod.

C. Buried earthing conductors are to be laid at a depth not less than 0.5 m from ground surface .

D. Earthing conductors are to follow shortest path between earth rods and main earthing terminals or bars, and are to run in PVC conduit (duct) fastened to building structure by approved supports and extending 0.2 m above level, and are to be protected against mechanical damage and corrosion.

E. Protective Conductors: Separate protective conductors, which are not part of a cable, are to be fixed on same support or drawn into same conduit as circuit conductors.

F. Protective Bonding: Remove any non-conductive paint, enamel or similar coating at threads, contact points and surfaces and ensure that bonding is made by fittings designed to make secure bonds.

330.080 CONNECTIONS

A. Protection against Corrosion: Protect bolted connections against corrosion either by filling with Vaseline or coating with a special anti-corrosion compound and proper capping.

B. Connections: Earth connections are to be readily accessible. If inaccessible earth connection is permitted, approved exothermic welding or brazing technique is to be employed.

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C. Connections: Where earth connections between dissimilar metals must be made, use bimetallic fittings and protect by coating with moisture resisting bituminous paint or compound, or by wrapping with protective tape to exclude moisture.

D. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.

E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in applicable Standards.

330.090 FIELD QUALITY CONTROL

A. Combined resistance of earth electrodes is to be measured during dry season and checked against specified resistance.

B. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

C. Electrical continuity of all earthing and protective conductors including main and supplementary equipotential bonding conductors is to be checked.

D. Earth fault loop impedance of all circuits is to be measured and checked against calculated impedance figures.

E. Operation of residual current protective devices is to be checked.

330.100 GRADING AND PLANTING

A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with the relevant Landscape Sections. Maintain restored surfaces. Restore disturbed paving as indicated.

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Y90 - FIXING TO BUILDING FABRIC

1010 PREPARATION:

- Mark-out, set-out and firmly fix all equipment, components and necessary brackets and supports.

1020 MANUFACTURER'S DRAWINGS:

- Use manufacturer's drawings and templates for purposes of marking and setting out.

1030 FIXINGS:

- Ensure structure and fixings are suitable for items to be fixed.

1040 LOADING DETAILS:

- Provide loading details for all fixing types.

1050 BUILDING-IN BY OTHERS:

- Provide all necessary assistance to enable any item of building-in type to be built in by others.

1060 SIZE OF FIXING:

- Use largest size of bolt, screw or other fixing permitted by diameter of hole in item to be fixed.

1070 GREASING OF FIXINGS:

- Ensure all bolts, screws or other fixings used are greased or lubricated in accordance with manufacturer's instructions.

2000 PRODUCTS/MATERIALS

2010 STANDARDS:

- Ensure that fixings such as expanding anchors are tested for tensile loading in accordance with BS 5080-1.

2020 PLUGS:

- Use plugs of suitable size and length for fixings. Use plastic, fibrous or soft metal non-deteriorating plugs to suit application. Do not use wood plugs.
- Ensure that when screw is in place, threaded length is in plug. Ensure plugs used for screw fixing are set-in to correct depth prior to final tightening.

2030 SCREWS:

- Use screws to BS 1210. Generally use sheradised steel wood screws for fixing to concrete, brickwork or blockwork.
- In damp or exposed situations use greased brass wood screws.

2080 NON-PENETRATIVE SUPPORT SYSTEMS FOR ROOF MOUNTED EQUIPMENT:

- Obtain approval prior to using non-penetrative support systems for roof mounted equipment.

3000 WORKMANSHIP

3010 DRILLING:

- Drill holes squarely. Use drills of requisite size and depth, and appropriate to fabric. Do not flame-cut holes in metal work.

3050 FIXING TO TIMBER RAILS:

- Fix equipment, brackets and supports by drilling hole through timber rail and fixing with bolt, back plate, washer and loose nut.

3060A FIXING TO HOLLOW STUD/TILE/BLOCK WALLS:

- Fix equipment, brackets and supports where there is access at rear of wall, by drilling hole through wall and fixing with bolt, back-plate, washer and loose nut.
- Fix equipment, brackets and supports where there is no access at rear of wall, drill hole and use screw anchor type fixing or gravity type toggle fixing.

3070A FIXING TO CONCRETE, BRICKWORK OR BLOCKWORK:

- Fix equipment, brackets and supports using wood screws in plugs or, as appropriate, drill holes and fix using steel bolts of grouted bolt type or expanding bolt type fixing.

3080A FIXING TO METALWORK:

- Fix equipment, brackets and supports by drilling holes and fixing using set screws or bolts complete with washers, shakeproof washers and loose nuts.

3090A FIXING TO STRUCTURAL STEELWORK AND CONCRETE STRUCTURES:

- Provide manufacturer's information on recommended fixing. Obtain approval for any fixing to structure steel work and concrete structures.
- Generally use proprietary fixings to structural steelwork and concrete structures.
- Obtain approval to cut holes in structural steelwork or concrete structures or weld to structural steelwork.

Y91 - PAINTING AND ANTI-CORROSION TREATMENTS

1010 GENERAL REQUIREMENTS:

- Ensure, where particular methods of finish and painting are not specified, the following requirements are met.
- Protect all metal work, plant, equipment, pipelines, ductlines, ancillaries, brackets and supports against corrosion and oxidization.
- Provide ferrous metals, machined or otherwise with protective coatings at manufacturer's works.
- Ensure all items requiring on-site decorative finishes are provided primed to suit base material and required finish.

1020 DAMAGED FINISHES:

- Following delivery to site, storage on-site and installation make good any damage to finishes, by cleaning, degreasing and re-furbishing.

2000 PRODUCTS/MATERIALS

2010A PAINT MATERIALS:

- Use the following materials as appropriate
    - Solvent borne priming paint to BS 7956 for bare woodwork.
    - Red Oxide priming paint for bare iron and steelwork.
    - Zinc Chromate priming paint for bare ferrous and non-ferrous metals.
    - Calcium Plumbate priming paint to BS 3698 for galvanized steel or composite wood/metal components.
    - Undercoat paint for previously primed or painted surfaces before the application of finishing coats.
    - Gloss finishing paint for previously primed or painted/undercoated surfaces.
    - Epoxy resin paint for specialist coatings requiring resistance to acids, alkalis, oils, solvents, abrasion or high humidity.
    - Aluminium paint to BS 388 for structural steelwork, storage vessels, heated metallic surfaces and similar applications where moisture and heat resistant properties are required.
    - Cold galvanizing paint for making good damage to previously galvanized surfaces and protection to galvanized materials modified during installation.
    - Zinc-rich metallic to BS 4652 for bare iron and steelwork where electrical conductivity has to be assured.
    - Black tar-based paint to BS 1070 for moisture resistant protection to metal surfaces where decorating appearance is not important.
    - Bitumen based coatings for cold application to BS 3416 protection to iron and steel, particularly pipelines and fittings for use in contact with potable water.
    - Bitumen based coatings for cold application to BS 6949 not to be used in contact with potable water.

2020 PAINT QUALITY:

- Ensure paints used are of quality and type to suit application and that:-
  - primers have good adhesion, covering power, rust-inhibiting and grain filling properties.
  - gloss finishing paints are of machine finish grade having high adhesion and high resistance to solvents, mineral oils, cutting oils, detergents, chipping and impact damage.

3000 WORKMANSHIP

3020 WEATHER AND OTHER CONDITIONS:

- Do not apply paints where weather, temperature, humidity or other conditions may have a damaging effect upon finish or paint.

3030# CLEANING:

- Ensure metal surfaces are thoroughly cleaned, all mill and weld scale removed and finally degreased.
- Clean steel surfaces in accordance with BS EN ISO 8503.
- Prepare surfaces for painting in accordance with BS EN ISO 4618.

3030A CLEANING AND PREPARING STEEL SURFACES FOR PAINTING:

- Ensure metal surfaces are thoroughly cleaned, all mill and weld scale removed and finally degreased. Clean steel surfaces in accordance with BS EN ISO 8503 and prepare surfaces for painting in accordance with BS EN ISO 4618.

3030B CLEANING AND PREPARING SURFACES FOR PAINTING:

- Ensure metal surfaces are thoroughly cleaned, all mill and weld scale removed and finally degreased.
- Prepare surfaces for painting in accordance with BS EN ISO 4618.

3040 APPLICATION OFF-SITE:

- Wherever possible ensure paint finishes applied by component manufacturers are spray applied.

3050 APPLICATION:

- Apply paint evenly and ensure finish shows no excessive brush marks, grinning, runs, sagging, ropiness or other application defects.

3060 COLD GALVANIZING:

- Repair damage to galvanized components due to installation process, i.e. following cutting, drilling or welding, by applying 2 no. substantial coats of cold galvanizing paint.

3070 PROTECTION OF BRIGHT MACHINE PARTS:

- Apply a protective coating to all bright machined parts before despatch from works.
- Do not remove protective coatings unless required for installation, testing or commissioning purposes and in such cases reinstate upon completion.
- Repair any damaged protective coating or bright machined part, or where necessary replace damaged component.
- Use and apply metal coatings in accordance with manufacturer's instructions.
- Complete where possible all welding, drilling, bending and other work before metal coating.

Y92 - MOTOR DRIVES - ELECTRIC

1010 STANDARDS:

- Supply and install motors in accordance with BS EN 50347, for dimensional requirements of general purpose 3-phase induction motors, relevant parts of BS EN 60034, BS EN 62262 and BS 4999 as appropriate; and local supply authority regulations.
- Electrical equipment intended for use in potentially hazardous areas / explosive atmospheres to comply with relevant parts of BS EN 60079 and be tested, certified and marked that the equipment is fit for its intended purpose and that adequate information is supplied with it to ensure that it can be used safely.

1040# SURGE SUPPRESSORS:

- Refer to Section W57 for surge suppressors.

1050A MANUFACTURER FITTED TRANSIENT SURGE SUPPRESSORS:

- Supply built-in transient surge suppressors across the starter contactor coils. Fitted by manufacturer.

1050B INSTALLER FITTED TRANSIENT SURGE SUPPRESSORS:

- Supply external transient surge suppressors across the starter contactor coils. Fitted by installer.

2000 PRODUCTS/MATERIALS:

2010A STANDARD OPERATING CONDITIONS:

- Ensure motors, starters and ancillary equipment are suitable for operation at full capacity at heights above sea level not exceeding 1000m, with air cooling at an average temperature over 24 hours not exceeding 35°C dry bulb with maximum conditions of 40°C dry bulb and 50 per cent RH.

2010B NON STANDARD OPERATING CONDITIONS:

- Ensure motors, starters and ancillary equipment are suitable for operation at full capacity at heights above sea level above 1000m, with conditions exceeding 40°C, and up to 50°C dry bulb and 50 per cent RH.

2020 MOTORS - GENERAL:

- Standard
    - Use motors which conform to BS EN 60034, as applicable, which operate at lowest possible speed, compatible with performance requirements.
    - Terminal markings and direction of rotation to be in accordance with BS EN 60034-8
    - Provide isolation during repair and maintenance work in accordance with BS EN 62626-1

- Comply with EC Regulation 640/2009 and amendment EU Regulation 4/2014 with regard to ecodesign requirements for electric motors.
- Electrical supply to BS EN 60038
    - Motors 0.746 kW (1 HP) and Larger: Three phase.
    - Motors smaller than 0.746 (1 HP): Single phase.
- Ratings
    - Select maximum continuous rating (MCR) such that driven machine operates at correct speed or speeds at design duty.
- When running continuously at design rated duty, the temperature of the motor parts is within limits defined in BS EN 60034-1
- When provided with excess motor current (over-load) protection of thermal overcurrent release type, ensure operation is within tolerances of tripping as defined in BS EN 60947-4-1.
- Insulation
    - Single phase motor
        - Use motors with Class 130 to BS EN 60085 insulation, unless indicated otherwise.
    - Three phase motor
        - Use motors with Class 155 to BS EN 60085 insulation, with Class B temperature rise as defined in BS EN 60034-1, unless recommended otherwise by manufacturer and approved by Engineer for specific applications such as: overhead cranes or submersible pumps, where Class 180 to BS EN 60085 insulation is to be used, with Class F temperature rise as defined in BS EN 60034-1
- Ventilation enclosure
    - Low Voltage Motors' Enclosure: Totally enclosed, fan-cooled type (TEFC) to IC 411 to IEC 60034-6 as applicable, unless otherwise indicated or recommended by manufacturer and approved by the Engineer.
    - Medium Voltage Motors' Enclosures: Totally enclosed, air to air cooled (TEAAC) to IC 611 to IEC 60034-6 as applicable or totally enclosed, water to air cooled (TEWAC) to IC 817 to IEC 60034-6 as applicable. Enclosure type shall be as recommended by manufacturer and approved by the Engineer, unless otherwise indicated.
- Conduit entry
    - Fit motor bodies with conduit entry terminal box or cable gland as required, and to suit type and size of cable being terminated.
- Comply with BS EN 60034-5 and BS EN 62262 to achieve the specified degrees of protection classification provided by the integral design.

2025A MOTOR EFFICIENCY:

- Supply an IE2 motor with a minimum efficiency compliant with BS EN 60034-30-1 as shown in the table below:

IE2 Motor Efficiency Limits (%) for 50 Hz: figures taken from BS EN 60034-30-1 Table 5				
Rated Power (kW)	No. of Poles/Synchronous Speed (RPM)			
	2/3000	4/1500	6/1000	8/750

0.12	53.6	59.1	50.6	39.8
0.18	60.4	64.7	56.6	45.9
0.20	61.9	65.9	58.2	47.4
0.25	64.8	68.5	61.6	50.6
0.37	69.5	72.7	67.6	56.1
0.40	70.4	73.5	68.8	57.2
0.55	74.1	77.1	73.1	61.7
0.75	77.4	79.6	75.9	66.2
1.1	79.6	81.4	78.1	70.8
1.5	81.3	82.8	79.8	74.1
2.2	83.2	84.3	81.8	77.6
3	84.6	85.5	83.3	80.0
4	85.8	86.6	84.6	81.9
5.5	87.0	87.7	86.0	83.8
7.5	88.1	88.7	87.2	85.3
11	89.4	89.8	88.7	86.9
15	90.3	90.6	89.7	88.0
18.5	90.9	91.2	90.4	88.6
22	91.3	91.6	90.9	89.1
30	92.0	92.3	91.7	89.8
37	92.5	92.7	92.2	90.3
45	92.9	93.1	92.7	90.7
55	93.2	93.5	93.1	91.0
75	93.8	94.0	93.7	91.6
90	94.1	94.2	94.0	91.9
110	94.3	94.5	94.3	92.3
132	94.6	94.7	94.6	92.6
160	94.8	94.9	94.8	93.0
200	95.0	95.1	95.0	93.5

2025B MOTOR EFFICIENCY:

- Supply a IE3 motor with a minimum efficiency compliant with BS EN 60034-30-1 as shown in the table below:

IE3 Motor Efficiency Limits (%) for 50 Hz: figures taken from BS EN 60034-30-1 Table 7				
Rated Power (kW)	No. of Poles/Synchronous Speed (RPM)			
	2/3000	4/1500	6/1000	8/750
0.12	60.8	64.8	57.7	50.7
0.18	65.9	69.9	63.9	58.7
0.20	67.2	71.1	65.4	60.6
0.25	69.7	73.5	68.6	64.1
0.37	73.8	77.3	73.5	69.3
0.40	74.6	78.0	74.4	70.1
0.55	77.8	80.8	77.2	73.0
0.75	80.7	82.5	78.9	75.0
1.1	82.7	84.1	81.0	77.7
1.5	84.2	85.3	82.5	79.7
2.2	85.9	86.7	84.3	81.9
3	87.1	87.7	85.6	83.5
4	88.1	88.6	86.8	84.8

5.5	89.2	89.6	88.0	86.2
7.5	90.1	90.4	89.1	87.3
11	91.2	91.4	90.3	88.6
15	91.9	92.1	91.2	89.6
18.5	92.4	92.6	91.7	90.1
22	92.7	93.0	92.2	90.6
30	93.3	93.6	92.9	91.3
37	93.7	93.9	93.3	91.8
45	94.0	94.2	93.7	92.2
55	94.3	94.6	94.1	92.5
75	94.7	95.0	94.6	93.1
90	95.0	95.2	94.9	93.4
110	95.2	95.4	95.1	93.7
132	95.4	95.6	95.4	94.0
160	95.6	95.8	95.6	94.3
200	95.8	96.0	95.8	94.6

2030 SLIDE RAILS:

- Fit motors on slide rails or other suitable means of adjustment to facilitate correct alignment and belt tension.

2040 PLINTHS:

- Where plinths are built in by others, provide all necessary assistance and information.

2060# MOTORS - OVER TEMPERATURE PROTECTION:

- Thermistors
  - Fit positive temperature coefficient thermistors to BS EN 60034-11. Provide a minimum of 3PTC thermistors in each motor with 2 ends terminated in motor terminal box clearly and permanently marked.
  - For motors rated between 30kW and 75kW provide a single thermistor in each phase.
- Provide control unit to BS EN 60034 to motors fitted with thermistors.
- Interconnect control unit with thermistors and starter to trip starter when one or all of thermistors detect overheating.

2060A MOTORS - OVER TEMPERATURE PROTECTION, THERMISTORS:

- Fit positive temperature coefficient thermistors to BS EN 60034-11. Provide a minimum of 3 PTC thermistors in each motor with 2 ends terminated in motor terminal box clearly and permanently marked.
  - For motors rated between 30kW and 75kW provide a single thermistor in each phase.
- Provide control unit to BS EN 60034 to motors fitted with thermistors. Interconnect control unit with thermistors and starter to trip starter when one or all of thermistors detect overheating.

2070A INDIRECT DRIVES WITH TOOTHED BELTS:

- Belts

- Use toothed wedge belts to BS 3790. Provide at least two matched belts for any drive, of anti-static type and rated to transmit full machine power with one belt removed.

- Pulleys
  - Construct pulleys from approved materials and statically balance. Lock close limit bores by keys fitting into machinery shaft keyway.
- Pulley adjustment
  - Adjust pulley to give alignment and correct belt tension.

2070B INDIRECT DRIVES WITH FLAT BELTS:

- Belts
  - Use flat wedge belts to BS 3790. Provide at least two matched belts for any drive, of anti-static type and rated to transmit full machine power with one belt removed.
- Pulleys
  - Construct pulleys from approved materials and statically balance. Lock close limit bores by keys fitting into machinery shaft keyway.
- Pulley adjustment
  - Adjust pulley to give alignment and correct belt tension.

2080# DIRECT COUPLED DRIVES:

- Use an extended motor shaft coupled to machine.
- Use a flexible coupling connecting driving and driven shafts, incorporate suitable arrangements for aligning the two shafts.
- Mount motors on a substantial mild steel bed plate fixed to machine casing
  - Separately supported.
  - Supported entirely from the machine casing.

2080A DIRECT LONG COUPLED DRIVES:

- Use an extended motor shaft coupled to machine or a flexible coupling connecting driving and driven shafts, incorporate suitable arrangements for aligning the two shafts.
- Mount motors on a substantial mild steel bed plate fixed to machine casing separately supported or supported entirely from the machine casing.

2090# GUARDS:

- Totally protect drives and couplings. Fit purpose made guards around all exposed or otherwise accessible drive shafts, pulleys, V-belts or couplings.
- Ensure guards comply with national or local safety codes, Acts and Bylaws and incorporate following features:
  - Construction to BS EN ISO 12100 and generally of galvanized steel wire mesh
  - Stiffening within the guards to ensure rigidity and freedom from vibration
  - Allowance for prime mover adjustment during belt tensioning procedures
  - Temporary access to all shafts for use of Tachometer

2090A GUARDS:

- Totally protect drives and couplings. Fit purpose made guards around all exposed or otherwise accessible drive shafts, pulleys, V-belts or couplings.
- Ensure guards comply with national or local safety codes, Acts and Bylaws and incorporate following features
    - Construction to BS EN ISO 12100 and generally of galvanized steel wire mesh
    - Stiffening within the guards to ensure rigidity and freedom from vibration
    - Allowance for prime mover adjustment during belt tensioning procedures
    - Temporary access to all shafts for use of Tachometer

2100# MOTOR MOUNTING CLASSIFICATION:

- Standard - BS EN 60034-7
    - Code I classification - IM.
        - Alpha code.
            - B.
            - V.

Y92A - MOTOR-CONTROL CENTERS

PART 1 SYSTEM OBJECTIVES

100.000 PERFORMANCE OBJECTIVES

100.010 SUMMARY

A. This Section includes motor control centers and panels for use on ac circuits rated 600 V and less. It includes a Connection to BMS system, including interface elements such as relays, transducers, etc. as detailed in the mechanical specifications, BMS schedules and/or shown on drawings.

110.000 DESIGN PARAMETERS

110.010 REFERENCE STANDARDS

A. Comply with the Following Standards:

1. IEC 61439-1.
2. IEC 61439-2.
3. IEC 60204.

120.000 SYSTEM DESCRIPTION

120.010 VARIABLE FREQUENCY DRIVE

A. Furnish complete variable frequency drives as specified herein for the fans and pumps designated to be variable speed. All standards and optional features shall be included within the VFD enclosure, unless otherwise specified. VFD enclosure shall be IP 21 and IP 54 to IEC 60529 with inlet air filters. Drive shall be mounted on a floor stand.

B. VFD shall be provided for motor starting and speed control where specified or shown on electrical or mechanical drawings.

C. VFD shall convert three-phase, 50 hertz utility power to adjustable voltage and frequency, three phase power for stepless motor speed control from 10% to 100% of the motor's 50 hertz speed. Input voltage shall be as specified on the drawing schedules.

D. VFD shall include a converter and an inverter section. The converter section shall convert fixed frequency and voltage AC utility power to DC voltage. All VFDs shall include input line reactors or an isolation transformer as required. The inverter section of the VFD shall invert the DC voltage into a quality output waveform, with adjustable voltage and frequency for stepless motor speed control. The VFD shall maintain a constant V/Hz ratio. The VFD and options shall be tested to IEC 60947-4-1.

E. Power line noise shall be limited to a voltage distortion factor and line notch as defined in IEC 61000 as follows:

1. For motors with full load current below 16 A, comply with IEC 61000-3-2, and as a minimum use 6-pulse rectifier with DC buffer.
2. For motors with full load current below 75 A, comply with IEC 61000-3-4, and as a minimum use 6-pulse rectifier with 3% AC line reactor and DC buffer.
3. For motors with full load current exceeding 75 A and up to 450 A, comply with IEC 61000-3-4, and as a minimum use 6-pulse rectifier with 5% AC line reactor and DC buffer.
4. For motors with full load current exceeding 450 A, comply with IEC 61000-3-4, and as a minimum use 12-pulse rectifier with two secondaries galvanic isolating transformer to provide the necessary phase shift and 5% AC line reactor and DC buffer; as an alternative, active front end technique with LCL filter may be used.

F. The VFD shall comply with EMC directive and standard IEC 61800-3 category C2 (1st environment), the VFD shall include EMC filter.

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G. Motor noise as a result of the VFD shall be limited to 3 dB over across the line operation measured at 1 meter from the motor's centerline.

H. VFD's full load amp rating shall meet or exceed NFPA 70, NEC Table 430-250.

I. Protective Features shall include the following:

1. Individual motor overload protection for each motor controlled.
2. Protection against input power under-voltage (for non-emergency motors only), over-voltage, and phase loss.
3. Protection against output current overload and instantaneous over-current.
4. Protection against over-temperature within the VFD enclosure.
5. Protection against over-voltage on the DC bus.
6. Thermistor motor protection relay interface.
7. Protect VFD from sustained power of phase loss. Under-voltage trip activates automatically when line voltage drops more than 10 percent below rated input voltage.
8. Automatically reset faults due to under-voltage, over-voltage, phase loss, or over-temperature.
9. Protection against output short circuit and motor winding shorting to case faults.
10. Status lights or digital display for indication of individual fault conditions.
11. Controller capable of operating without a motor or any other equipment connected to the drive output to facilitate start-up and troubleshooting.
12. Input line reactors shall be provided to minimize harmonics introduced to the AC line and to provide additional protection to AC line transients.

J. Interface Features for the VFD will include:

1. Door mounted Hand/Off/Auto selector switch to start and stop the VFD. In the Auto position, the VFD will start/stop from the controller. In the Hand position, the VFD will run regardless of the remote contact position.
2. Manual speed control capability.
3. Local/Remote selector switch. In the Remote position, motor speed is determined by the follower signal. In the local position, motor speed is determined by the manual speed control.
4. Power/On light to indicate that the VFD has tripped on a fault condition.
5. Digital meter with selector switch to indicate percent speed and percent load.
6. A set of form-C dry contacts, to indicate when the VFD is in the Run mode.
7. A set of form-C dry contacts, to indicate when the VFD is in the Fault mode.
8. A 0 to 10 V output signal to vary in direct proportion to the controller's speed.
9. VFD to have terminal strip and N.C. safety contacts such as freezstats, smoke alarms, etc. VFD to safety shut down in drive or bypass mode when contacts open.

K. Adjustments will include the following:

1. Maximum speed, adjustable 15 to 100 percent base speed.
2. Acceleration time, adjustable 3 to 60 seconds.
3. Deceleration time, adjustable 3 to 60 seconds with override circuit to prevent nuisance trips if decal time is set too short.
4. Current limit, adjustable 0 to 105 percent.
5. Overload trip set point.
6. Offset and gain to condition the input speed signal.

L. Service conditions will cover:

1. Ambient temperature, 0 to 50 deg C.
2. 0 to 95 percent relative humidity, non-condensing.
3. Elevation to 1,000 meters without derating.
4. AC line voltage variation, -10 to +10 percent of nominal.

M. Control interface: VFD shall be equipped with field-bus module for remote control, monitor and display VFD status and alarms from the BMS. Coordinate with BMS for the interface protocol to be adapted and provide the necessary adapter modules accordingly.

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120.020 STARTERS

A. Starters for three phase motors to be magnetic type to automatically disconnect motor from power supply in case of supply failure, excessive voltage drop, overcurrent and lack of balance in phases. Overload trips to be provided for three phases.

B. Motor Data: Obtain from equipment supplier before ordering any motor starter, or check motor nameplate for full load current rating and allowable temperature rise in order to select proper overload thermal element for motor starter.

C. Short circuit protection device fitted to starter to be independent of controller and overload protection.

D. Control voltage for starters and control circuits shall not exceed 110 V.

E. Step Down Control Circuit Transformers: Two winding isolating type.

F. Control Circuit Protection: Use high rupturing capacity fuses or circuit breakers.

G. Auxiliary supply for controls other than from main power circuit, to be effectively isolated by auxiliary contacts on main isolator.

H. Control devices on starters to be as follows unless otherwise indicated or required by driven equipment: start stop push buttons, one red pilot light for "running", one green pilot light for "stopped", one amber pilot light for overload trip, and one reset push button.

I. All motors shall be protected with overload protection class 10 to IEC 60947-4-1, unless otherwise required by the motor manufacturer.

J. Starter type A for single phase motors not exceeding 1/2 HP to be surface or flush mounted, manual two pole toggle type, for non reversing across the line starting, fitted with one overload element.

K. Starter type B for three phase motors not exceeding 10 HP to be direct on line, non reversing, magnetic type, with manual reset, 3 pole overload relay and under voltage protection (for non-emergency motors only), unless otherwise required by local regulations or shown on drawings.

L. Starter type C for three phase motors over 10 HP, but not exceeding 50 HP, to be automatic star delta magnetic non reversing type, with 3 pole overload relay and under voltage protection (for non-emergency motors only), unless otherwise required by local regulations or shown on drawings.

M. Starter type D for three phase motors over 50 HP to be multiple step auto transformer non reversing magnetic type, with 3 pole overload relay, under voltage protection (for non-emergency motors only), unless otherwise required by local regulations or shown on drawings.

N. Electronic Solid State Reduced Voltage Motor Soft Starter shall be provided where specified or shown on the electrical or mechanical Drawings. Soft Starter shall be UL listed, consisting of silicon controlled rectifier (SCR) based power section, digital logic board and paralleling bypass contractor to provide smooth, stepless acceleration for AC, 3-phase, 400V, 50 Hz induction motors. Soft starter shall be provided for soft starting of motors where required on drawings. The minimum peak inverse voltage rating of the SCR's to be 1500 V. Contactor shall be rated for full voltage across the line motor starting duty. Starter enclosure shall be IP 52 protection for indoor installation and IP 55 for installations in wet and outdoor areas and provided with necessary ventilation fans. Where shown on the drawings or indicated in the motor center schedules, starter shall be incorporated within motor control center. The starter shall provide the following protections and adjustments:

1. Adjustable electronic overload.
2. Overhead protection for the starter.
3. Phase sequence protection.
4. Phase loss/unbalance protection.
5. Under-voltage protection (For Non-Emergency motors only).
6. Ramp time.
7. Initial torque.
8. Start current limit.
9. Motor full load current.
10. Starter shall comprise molded case motor circuit protector (with magnetic trip only) for short circuit protection. Starter shall be rated for 125% of the continuous current rating of the motor.

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Short circuit rating of start shall be at least 110% of the short circuit level at starter location, or as shown on the electrical drawings or indicated in the motor control center schedules. Soft starters for pumps shall comprise smooth soft facility for linear voltage deceleration with adjustable deceleration time.

O. Individually mounted starters to be totally enclosed in sheet steel enclosure with baked enamel finish. Design shall suit location and application. It shall be impossible to open enclosure door unless isolator is in open position.

P. Nameplates: Starters and controls to have engraved nameplates identifying system or defining its function.

Q. Contactors: Comply with IEC 60947-4, utilization category AC3, and be 3-phase, 3-pole, magnetic type, 600 V rating, capable of interrupting at least ten times rated current inductive or non-inductive loads under normal service conditions and shall have replaceable main arcing contacts and arc quenching devices. Contactors shall withstand, without welding or burning of contacts, an inrush current of 20 times normal rating for 4 seconds upon closing and shall be capable of closing on the heaviest short-circuit of the system and withstand the short-circuit for period required by upstream short-circuit protective device to operate. Three N.O. and three N.C. spare contacts shall be provided on each contactor.

R. Starter Co-Ordination: Motor starter devices shall be of type 2 co-ordination to IEC 60947-4-1. For variable frequency drives, fast acting semiconducting fuse category gR to IEC 60269-4 or approved equal shall be provided in case type 2 coordination cannot be achieved, to limit the let-through energy.

S. Fuses shall be provided with a monitoring facility for an immediate tripping after any fuse is blown to prevent single phasing. The monitoring shall reset automatically after the replacement of the blown fuse(s).

120.030 SWITCH DISCONNECTORS

A. Switch Disconnectors: non fusible, single throw type, with AC-23 utilization category to IEC 60947-3 for AC motors, housed in separate metallic enclosure, with arc quenching devices on each pole capable of interrupting at least six times its rated current. They shall simultaneously interrupt power supply to all line conductors, any neutral and control circuits.

B. Isolating Switches for single phase fractional horsepower motors to be double pole, dolly operated type, rated 15/20 A at 250 V AC, quick make, quick break, with silver alloy contacts, flush or surface mounted to suit application.

C. Operating Mechanism to be quick make quick break type, with external operating handle mechanically interlocked with enclosure cover to necessitate disconnecting switch to be in OFF position for access to inside of enclosure. Means shall be provided for by passing interlocks. Position of isolating switch shall be clearly indicated on cover.

D. Enclosure to be general purpose type, unless otherwise indicated or required, with provision for locking operating handle in OPEN and CLOSED positions.

E. Enclosures where indicated or required by location to be weatherproof totally sealed water and dustproof type.

120.040 COMBINATION STARTER SWITCH DISCONNECTOR

A. Components to comprise magnetic starter switch disconnector and short circuit protection devices required by the Standards, in approved sheet metal enclosure to suit application.

B. Switch Disconnector Operating Mechanism: Quick make, quick break, with external operating handle mechanically interlocked with enclosure cover necessitating disconnecting switch to be in OFF position for access to inside of enclosure. Means shall be provided for by passing interlocks. Position of isolating switch to be clearly indicated on cover.

C. Short circuit protection gear shall be HRC fused cartridges or molded case circuit breakers of appropriate current rupturing capacity. Switch disconnectors are not required if circuit breakers are

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used for the short circuit protection. In this case the circuit breaker will perform the disconnection function.

D. Operation of circuit breaker to be possible from outside of enclosure. Position of breaker ON/OFF/TRIPPED to be clearly indicated by position of handle.

120.050 PUSH BUTTONS

A. Push buttons to be one unit momentary contact START/STOP with normally open or normally closed contacts as required by wiring diagrams and with lockout attachments. Heads to be color-coded and STOP button to be protected. Push buttons controlling one piece of equipment to be housed in separate enclosure.

120.060 RELAYS

A. Relays to be multi-pole with normally open or normally closed contacts, electrically operated at 110 V maximum, and magnetically held. Contacts to be double break silvered type, interchangeable from normally open to normally closed without additional parts. Relays shall be rated at 10 A, 600 V.

120.070 CIRCUIT PROTECTORS AND SWITCHES / CIRCUIT BREAKERS

A. Circuit Breakers to give positive trip free operation on abnormal overloads, with quick make quick break contacts under both manual and automatic operation. Stationary and movable contacts to be non welding silver alloy adequately protected with effective and rapid arc interruption.

B. Motor Circuit Protector: Molded case, magnetic break type with adjustable instantaneous setting suitable for motor protection.

C. Molded Case Switch: Similar to circuit breakers but without overload/short circuit protection. Short time rating of switches shall not be less than twelve times the maximum rated operational current for 1 second. Switches shall comply with IEC 60947-3. Switches shall have utilization category AC-23B to IEC 60947-3.

D. Branch Circuit Breakers to be 160 A minimum frame size, unless otherwise shown on the drawings.

E. Circuit Breakers And Motor Circuit Protectors shall be in compliance with IEC 60947-2, utilization category B (for frame ratings 800A and above), utilization category A (for ratings up to 630A), sequence II (service capacity) for motor control centers and sequence III (ultimate capacity) for motor control panels and combination starters unless otherwise indicated on the drawings.

F. Electronic Trip Unit: circuit breaker electronic trip unit shall be provided with adjustable long time, short time and instantaneous current setting. In addition adjustable earth fault protection shall be provided on trip units for main incoming circuit breakers.

G. Main incoming breakers/switches to be equipped to provide earth fault phase failure and phase sequence protection through shunt trip coil. Earth fault detection and interruption to be time coordinated with those of main incoming breaker on main distribution board.

H. Molded Case Circuit Breaker (MCCB) for ratings up to 1250A and Air Circuit Breaker (ACB) for ratings greater than 1250A.

I. Multiple Pole Breakers to have single handle mechanism. Each pole to have inverse time delay thermal overcurrent trip element and magnetic instantaneous overcurrent trip element for simultaneous tripping of all poles.

J. Trip Elements to be ambient temperature compensated type.

120.080 MOTOR CONTROL CENTER (MCC)

A. Type: Totally enclosed, free-standing sectionalized type, modular, compartmented suitable for frame ratings of main circuit breaker and busbars of 630 A or above, form 3b to IEC 61439-1 & -2 with separate withdrawable section for each motor starter and separate fixed section for main incoming breaker / switch and each outgoing feeder circuit breaker. Sections to be designed to allow other sections to be easily added or removed.

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B. General Construction: Rigidly framed and bolted, with Electro-galvanized sheet steel enclosures, phosphatized, primed with rust inhibiting primer and finished with thermal polymerized polyester epoxy powder coating, gray color (RAL 7035 ANSI 61) to approval. Motor control center shall be vermin, dust and rodent proof, IP 31 protection to IEC 60529 for indoor installations, IP 54 protection for installations in wet areas (e.g. pump rooms) and for motor control centers serving life safety and firefighting equipment and IP 55 protection for outdoor installations, with adequate lifting means and base-frames and capable of being moved into position and directly bolted to floor without additional sills. For ratings up to 3200A, enclosures shall have mechanical impact resistance of IK10 to IEC 62262 for enclosures protection degree IP 54 and higher, and IK08 to IEC 62262 for enclosures protection degree lower than IP 54. Test certificates for mechanical impact shall be submitted for approval; otherwise enclosure thickness shall not be less than 1.5mm. For ratings larger than 3200A, enclosures shall have minimum thickness of 2mm. Fronts shall be single or twin covers to shield circuit breakers, terminals and live ends.

C. Components: Motor control center shall include the following:

1. Main incoming circuit breaker or isolating switch as shown on the Drawings for terminating incoming supply cables and isolating the busbar system.
2. Main copper horizontal full-length busbars.
3. Branch copper vertical full height busbars.
4. Neutral copper busbar rated at half capacity of main busbar and distributed throughout whole motor control center.
5. Earth copper busbars minimum 25 x 6 mm extending full length of motor control center.
6. Digital multimeter unit with necessary current transformers at incoming feeder(s) as specified under Division Y Section “Switchboards”.
7. Starters, circuit breakers, push buttons, indicating lights, switches, relays, contactors and accessories as shown on the Drawings.
8. Interconnecting and interlock wiring.

D. Wiring: Motor control centers shall have factory wired terminal block, in compliance with IEC standard.

E. Busbars: Site rated to same rating of main circuit breaker frame size as a minimum unless otherwise shown on drawings, and braced for a symmetrical rms short-circuit duty as specified. Busbars shall be copper, of sufficient size to limit temperature rise to allowable equipment temperature ratings, and not exceeding IEC 61439-1&-2 limits. Connections and buswork shall be bolted with compatible hardware material as per manufacturer’s recommendations and shall be accessible for inspection and maintenance. Contact surfaces shall be properly tin or Electro-silver plated as necessary.

F. Connections from busbar to switching element and starter shall be rated to carry full continuous current rating of switching element frame as a minimum, unless otherwise shown on drawings.

G. Main horizontal busbars and vertical distribution busbars shall be insulated unless bare busbars are recommended by the manufacturer and used in the type test.

H. The motor control center shall be designed to minimize the risks associated with the propagation of an internal arc fault of 85 kA for 0.3 sec as a minimum. Motor control center shall be tested in accordance with IEC 61641 for internal arc protection.

I. All motor control centers fed from MDB shall be equipped with Class II surge protective devices as specified under Division W Section “Surge Protective Devices”. SPDs along with their fused-disconnect switch shall be integrated within or adjacent to the MCC’s enclosure.

J. Where single core cables are used, top / bottom cable entry plates shall be made of bakelite or Aluminum with adequate thickness and rigidity to support cables.

K. Compartment doors to be interlocked so that isolators or breakers must be in OFF position before door can be opened.

L. Spare Positions: Fully equipped cells, ready for connection to motors, shall be provided in adequate number.

M. Space Positions: Fully equipped cells ready to receive control unit shall be provided in adequate number. Space positions to have blank cover plates.

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N. Starters, switches, other components and electrical devices to be clearly labeled in English as to number and function, with incised letters on black Bakelite with white laminated core. Labels to be permanently fixed under each component.

O. Incoming line connections to be made with solderless, terminal four bolt type clamps.

P. Labels: Starters, switches, electrical devices and accessories to be clearly labeled in English as to function and number. Labels to be permanently fixed under each component.

Q. Schematic and wiring diagrams to be firmly fixed within motor control center, showing each component and cross- referenced with component labels.

R. Submit for approval electrical schematic diagram of whole installation suggested layout of motor control center, interior wiring details and complete technical literature on all proposed components, prior to fabrication or purchase.

120.090 MOTOR CONTROL PANELS (MCP)

A. Type: Wall mounted or unit mounted, lockable type, IP 31 for indoor installation and IP 54 for installation in wet areas and for motor control panels serving life safety and firefighting equipment and IP 55 for outdoor installations, with ratings of main breaker and busbars up to 400A, form 2a to IEC 61439-1 & -2.

B. Construction: hot-dip galvanized steel sheet, finished with one coat etch primer and one coat stove enamel internally and externally for cabinet/box; suitable for mechanical impact resistance of IK10 to IEC 62262 for enclosures protection degree IP 54 and higher and IK08 to IEC 62262 for enclosures protection degree lower than IP 54. Test certificates for mechanical impact shall be submitted for approval; otherwise enclosure thickness shall not be less than 1.5mm.

C. Components: Motor control panel shall include the following:

1. Main incoming circuit breaker or isolating switch as shown on the Drawings for terminating incoming supply cables and isolating the busbar system.
2. Copper main and branch busbars.
3. Neutral copper busbar rated at half capacity of main busbar.
4. Earth copper busbars rated at half capacity of main busbar.
5. Digital multimeter unit with necessary current transformers at incoming feeder(s) as specified under Division Y Section “Switchboards”.
6. Starters, circuit breakers, push buttons, indicating lights, switches, relays, contactors and accessories as shown on the Drawings.
7. Interconnecting and interlock wiring.

D. Wiring: Motor control panel shall have factory wired terminal block, in compliance with IEC standard.

E. Busbars: Site rated to same rating of main circuit breaker frame size as a minimum unless otherwise shown on drawings, and braced for a symmetrical rms short-circuit duty as specified. Busbars shall be copper, of sufficient size to limit temperature rise to allowable equipment temperature ratings, and not exceeding IEC 61439-1&-2 limits. Connections and buswork shall be bolted with compatible hardware material as per manufacturer’s recommendations and shall be accessible for inspection and maintenance. Contact surfaces shall be properly tin or Electro-silver plated as necessary.

F. Connections from busbar to switching element and starter shall be rated to carry full continuous current rating of switching element frame as a minimum, unless otherwise shown on drawings.

G. Main horizontal busbars and vertical distribution busbars shall be insulated unless bare busbars are recommended by the manufacturer and used in the type test.

H. All motor control panels shall be equipped with Class II surge protective devices as specified under Division W Section “Surge Protective Devices”. SPDs along with their fused-disconnect switch shall be integrated within or adjacent to the MCP’s enclosure.

I. Where single core cables are used, top / bottom cable entry plates shall be made of bakelite or Aluminum with adequate thickness and rigidity to support cables.

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J. Components: Panels shall contain necessary breakers, starters, push button switches, selector switches, relays, indicating lights, interconnecting and interlock wiring and all devices and accessories required for automatic or manual operation of equipment as specified under equipment concerned.

K. Labels: Starters, switches, electrical devices and accessories to be clearly labeled in English as to function and number. Labels to be permanently fixed under each component.

L. Schematic and wiring diagrams to be mounted in permanent approved manner on inside of panel door. Diagrams shall show each component cross referenced with component labels.

120.100 CONTROL SWITCHES

A. Float Switch: Level operated, heavy duty, bracket mounted type, suitable for application in open tanks, complete with 178 mm spun copper float, brass rod, two stops, floor mounting stand, lever and counterweight. Switch to have oil tight and dust tight enclosure and 2 pole double throw silver contacts that open on liquid rise.

B. Pressure Switch: Industrial, heavy-duty bellows actuated type, suitable for water service, with contacts to close on falling pressure. Range to be 0.1 to 8 kg/cm2. Switch to be good for 1720 kPa operating pressure and to have 6 mm pipe tap bottom connection. It shall have oil tight and dust tight enclosure, single pole double throw contacts and setting adjustment.

C. Low Suction Pressure Switch: Industrial, sensitive, low range, diaphragm actuated type, suitable for water service, with range of 2 to 20 kPa of falling pressure, preset at factory to 3 kPa. Switch to be good for 690 kPa operating pressure and to have 6 mm pipe tap bottom connection. It shall have oil tight and dust tight enclosure, single pole double throw contacts, range adjustment knob, sealing cap and range locking nut.

PART 2 REFERENCES

200.000 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and Division A Specification Sections, apply to this Section.

210.000 RELATED SECTIONS

A. Division P Section "Fire Stopping Systems" for electric motors.

B. Division R Sections for electric motors.

C. Division Y Sections "Air Ductlines and Ancillaries" for electric motors.

D. Division W Section "Central Control / Building Management ".

E. Division V Section "Basic Electrical Materials and Methods".

F. Division Y Section "Switchboards" for circuit breakers.

G. Division Y Section "Raceways and Boxes for Electrical Systems" for conduits.

H. Division Y Section "Low Voltage Electrical Power Conductors and Cables" for wires and cables.

I. Division V Section "Enclosed Switches and Circuit Breakers" for switch disconnectors.

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PART 3 PRODUCTS AND WORKMANSHIP

300.000 MATERIALS

300.010 MANUFACTURERS

A. Approved Manufacturers: Subject to compliance with requirements, provide products by one of the following or approved equal:

1. Rockwell Automation/Allen-Bradley Co.
2. Cutler Hammer/Eaton Corp.
3. General Electric
4. Moeller/Eaton corp.
5. Schneider Electric
6. Siemens
7. Schneider Electric / Square D Co.
8. ABB

B. Locally assembled products by one of the above approved manufacturers are acceptable subject to compliance with design requirements and adequacy of reference list and quality control of the local factory.

300.020 PRODUCTS

A. Products: Subject to compliance with requirements, provide one of the products indicated for each designation as shown on plans.

310.000 QUALITY MANAGEMENT

310.010 QUALITY ASSURANCE

A. Source Limitations: Obtain motor control devices through one source from a single manufacturer.

310.020 DELIVERY, STORAGE AND HANDLING

A. Deliver in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.

B. Deliver, store, and handle materials, components, and equipment as per Manufacturer's instructions.

310.030 COORDINATION

A. Coordinate features of controllers and accessory devices with pilot devices and control circuits to which they connect.

B. Coordinate features, accessories, and functions of each motor controller with the ratings and characteristics of the supply circuit, the motor, the required control sequence, and the duty cycle of the motor and load.

310.040 WARRANTY

A. Manufacturer's Warranty: Submit a written warranty signed by the manufacturer agreeing to repair, restore or replace any defective equipment specified in this section during the specified warranty period

1. Warranty Period: 1 year from date of Substantial Completion.

310.050 FACTORY ACCEPTANCE TEST

A. Factory acceptance tests of equipment under this Contract are subject to be witnessed by the Engineer for locally assembled equipment. Witness test shall include complete routine and function testing on all units to be witnessed. Test procedure and program shall be submitted for approval

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prior to test conduction. Allow for test expenses including business class transportation and hotel accommodation as necessary for two persons from the Engineer's/ Employer's side.

310.060 SPARE PARTS AND EXTRA MATERIAL

A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

1. Spare Indicating Lights: Furnish 6 of each type required.
2. Control Fuses: Furnish 10% of the total quantity of each rating used, with a minimum of one per type.
3. VFD Drives: For VFDs 50 HP and less, furnish one unit of each frame for quantities greater than five drives per frame, unless drives are provided with built-in manual bypass.

320.000 SUBMITTALS

A. Technical Data: Include dimensions, ratings and data on features and components.

B. For Variable Frequency Drives: Submit manufacturer's performance data including dimensional drawings, customer connection drawings, power circuit diagrams, installation and maintenance manuals, warranty description, VFDs FLA rating, certification agency file numbers and catalogue information.

C. Point-wise compliance statement to the specifications, duly signed by the manufacturer / manufacturer's authorized representative and the contractor.

D. Shop and Installation Drawings: Submit for each motor control center, and prior to ordering materials and equipment, specified in this Section. Include dimensioned plans, elevations, and component lists. Show ratings, including short time and short-circuit ratings, and horizontal and vertical bus ampacities.

1. Complete technical schedule of features, characteristics, ratings, and factory settings on all motor starters, motor protection relays, sensing units, control accessories, etc.
2. Instructional details of equipment, particularly motor control centers and panels.
3. Installation details of motor control centers and panels and of control and sensing accessories.
4. Exact routing of power and control cables, wiring and conduits.
5. Feeder termination details at motor control centers, starters, motors, isolating switches, control and sensing accessories etc.
6. Wiring Diagrams: Interconnecting wiring diagrams (of all power and control circuits) pertinent to class and type specified for motor control center. Schematic diagram of each type of controller unit indicated.
7. Wiring Diagrams: Submit for approval detailed control wiring diagrams and a list of control equipment with descriptive literature.
8. Free hand field wiring diagrams or sketches will not be accepted.
9. Factory certified routine test certificates to be submitted with each product delivered on site.

E. Maintenance Data: For products to include in the maintenance manuals specified in Division 01.

F. Submit certified protection relay coordination settings for review, along with certified "As-built" connection drawings, before energization of equipment.

G. As-built (Record) Drawings: At project close-out, submit certified record drawings of installed electrical motor control centers, in accordance with requirements of the specifications, Division 01.

H. Tests and Certificates: Submit complete certified manufacturer's type test and routine test records in accordance with the Standards.

330.000 EXECUTION

330.010 INSTALLATION

A. Install motor control centers according to manufacturer's written instructions.

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B. Anchor each motor control center assembly to steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by tack welding or bolting. Level and grout sills flush with motor control center mounting surface.

C. Install motor control centers on concrete housekeeping bases conforming to Division E Section “Accessories Cast Into In Situ Concrete."

D. Fuses: Install fuses in each fusible switch as indicated.

E. Power and Control Wiring: Run in separate conduits unless otherwise specified.

F. Rigid conduits shall not terminate in nor be fastened to a motor frame or base.

G. Flexible conduits to be used at motor connections. Allow sufficient slack to permit motor to slide over adjustable length of motor base.

H. Flexible Conduits: Length and radius to be sufficient to permit bending of feeder cables without damage to conductor or its insulation.

I. Flexible Conduits: Do not use in place of rigid conduits except at motor connections, unless otherwise specified.

J. Support conduit with conduit supports in an adequate approved manner.

K. Conduits shall not cross pipe or vent shafts, ducts or openings. They shall be run a minimum 100 mm away from pipes of non-electrical services.

L. Conduits: Install so that moisture can drain to lowest point. Provide screw plug at all low points for draining.

330.020 APPLICATIONS

A. Select features of each motor controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, drive, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

C. Push-Button Stations: In covers of magnetic controllers for manually started motors where indicated, start contact connected in parallel with sealing auxiliary contact for low-voltage protection.

D. Hand-off-automatic Selector Switches: In covers of manual and magnetic controllers of motors started and stopped by automatic controls or interlocks with other equipment.

330.030 IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs according to Division V Section "Basic Electrical Materials and Methods."

B. Operating Instructions: Frame printed operating instructions for motor control centers, including control sequences, and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of motor control centers.

C. Starters: Fix detailed wiring diagram inside enclosure cover to clearly indicate circuits.

D. Starters: Identify control and power wires either by distinctive colored insulation, engraved tags or other approved method.

330.040 CONTROL WIRING INSTALLATION

A. Bundle, train, and support wiring in enclosures.

B. Protect circuits with high rupturing capacity fuses or circuit breakers. Auxiliary supply for controls other than from main power circuit, to be effectively isolated by auxiliary contacts on main isolator.

C. Connect hand-off-automatic switch and other automatic control devices according to an indicated wiring diagram or one that is manufacturer approved, where available.

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1. Connect selector switches to bypass only the manual and automatic control devices that have no safety functions when switch is in the hand position.
2. Connect selector switches with motor control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor-overload protectors.

330.050 EARTHING

A. Earth motors by connecting green insulated conductor from earthing bushing in starter to motor frame. Run earth conductor together with circuit wiring and terminate in motor terminal box, provided earth terminal in box is connected to motor frame. If this is not feasible, extend earth conductor through insulated bushed opening in terminal box and connect to motor base.

B. Earth equipment by connecting non-current carrying metal parts of system to earth source. Non-currents carrying metal parts include conduits, cable trays, outlet boxes, cabinets, enclosures, doors, grilles, and barriers protecting or shielding electrical equipment from direct access.

330.060 CONNECTIONS

A. Tighten motor control center bus joint, electrical connector, and terminal bolts according to manufacturer's published torque-tightening values.

330.070 FIELD QUALITY CONTROL

A. Testing: After installing motor control center and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

1. Procedures: Perform recommended visual and mechanical inspection and electrical test. Certify compliance with test parameters.
2. Remove and replace malfunctioning units with new units, and retest.

B. Circuit Breakers: Co-ordinate earth fault detection and interruption with those of main incoming breaker on main distribution panel.

C. Pressure Switches: Test after installation to ensure dependable operation and correct setting.

D. Low Suction Pressure Switches: Test after installation to ensure dependable operation and correct setting

330.080 CLEANING

A. Inspect interior and exterior of motor control centers. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish. Clean devices internally, using methods and materials recommended by manufacturer.

330.090 DEMONSTRATION AND TRAINING

A. Train Employer's maintenance personnel to adjust, operate, and maintain the system installation. Refer to Division A Section "Demonstration and Training and Closeout Procedures."

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SECTION Y95 – SCADA FOR ELECTRICAL POWER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions and Division 01 Specification Sections, apply to this Section.

B. All the requirements presented in this Specification "SCADA for Electrical Power Systems" shall be complimentary to and shall apply to the following Specification Sections except where a particular Specification Section calls for otherwise. In this case, the individual Specification Section shall have precedence.

1.2 SUMMARY

A. Section includes a state-of the-art Supervisory Control And Data Acquisition (SCADA) for Electrical Power Systems automation at the Airport Project to achieve efficient supervision, control and operation of the following electrical network components:

1. Medium Voltage 11kV Switchgear.
2. Medium Voltage 11kV Main Ring Units.
3. 11/0.4kV Distribution transformers.
4. Low Voltage Main Distribution Boards.

B. The Supervisory Control And Data Acquisition (SCADA) functions comprise:

1. Local and remote operation of the LV and MV switchgear.
2. Acquisition of switchgear information and power system measurements.
3. Power quality analysis.
4. Handling of events and alarms.

C. A complete SCADA installation shall be provided comprising the following components as well as all material and services required for a complete and fully operational electrical power systems automation system in line with these Specifications:

1. Expansions and modifications of the existing SCADA Software.
2. Expansions and modifications of the existing Operator Workstations.
3. Expansions and modifications of the existing Web access Workstations (Clients).
4. Expansions and modifications of the existing System Servers.
5. Controllers RTU's/PLC's.
6. Interlocking, control relays, and similar components.
7. Human Machine Interface (HMI).
8. Power supplies and UPS.
9. Racks/Cabinets, Cubicles, Consoles.
10. System Cables.
11. Communication system including fiber optic network cabling, switches, gateways, software as well as all other accessories or equipment necessary to implement the required communication and interfaces.

D. Related Sections

1. Section - Basic Electrical Materials and Methods.
2. Section - Grounding and Bonding for Electrical Systems.

3. Section - Raceways And Boxes For Electrical Systems
4. Section - Cable Trays for Electrical Systems
5. Section - Underground Ducts and Raceways for Electrical Systems.
6. Section - Medium-Voltage Transformers.
7. Section - Medium-Voltage Ring Main Units.
8. Section - Static Uninterruptible Power Supply.
9. Section - Surge Protection for Low-Voltage Electrical Power Circuits.
10. Section – Common Clauses for Structured Cabling.
11. Section - Identification for Communications Systems.
12. Section - Communications Equipment Room Fittings.
13. Section - Communications Backbone Cabling.
14. Section - Communications Horizontal Cabling.
15. Section - Data Communications.
16. Section – Computers & Related Peripherals.
17. Section - Master Clock System (MCS).

E. Servers and related ancillaries shall comply with:
1. Division 27, Section “Computers & Related Peripherals”.

F. Workstations and related ancillaries shall comply with:
1. Division 27, Section “Computers & Related Peripherals”.

1.3 REFERENCE STANDARDS

A. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.

B. The publications listed below form a part of this specification. The publications are referred to in the text by basic designation only.

C. Specific reference in specifications to codes, rules, regulations, standards, manufacturer’s instructions, or requirements of regulatory agencies shall mean reference to the latest printed edition of each.

D. Conflicts

1. Should an instance occur in this Specification or on the Drawings in which material or construction methods called for is less than minimum requirement of the reference standards, immediately inform the Engineer in writing. Consequent to Engineer's approval, supply the materials and perform the work as though called for to minimum code standards.

E. Codes and Standards: All materials, installation and workmanship shall comply with the applicable requirements and standards addressed within the following references:

1. IEC 61850, Communication Networks and Systems in Substations.

2. IEC 60870, Telecontrol equipment and systems.

a. Part 5-101: Transmission protocols - Companion standard for basic telecontrol tasks
b. Part 5-104: Transmission protocols - Network access for IEC 60870-5-101 using standard transport profiles.
c. Part 6: Telecontrol protocols compatible with ISO standards and ITU-T recommendations.

3. IEC 61131, Programmable Controllers.

4. Electrical equipment, devices and components shall comply with the requirements of EMC:

    a. EN 61000-6-2, Electromagnetic compatibility (EMC). Generic standards. Immunity for industrial environments.
    b. EN 61000-6-4, Electromagnetic compatibility (EMC). Generic standards. Emission for industrial environments.

5. Information Technology equipment, devices and components shall comply with the requirements of:

    a. EN 55022, Information technology equipment. Radio disturbance characteristics. Limits and methods of measurement.
    b. EN 55024, Information technology equipment. Immunity characteristics. Limits and methods of measurement.

6. Code of Federal Regulations

    a. 47 CFR - Telecommunication, Chapter I - Federal Communications Commission, Part 15 - "Radio Frequency Devices."

7. All electrical works shall comply with DEWA Specifications and Regulations including but not limited to “Regulations for Electrical Installations”. Refer also to Section “Basic Electrical Materials and Methods”.

8. System Data Communications Network:

    a. Comply with the latest issue of several material and test standards, which have been developed and published by Institute of Electrical and Electronics Engineers (IEEE) for data communications industry, but not limited to:
        1) 802.1 – LAN/MAN Bridging and Management,
        2) 802.2 – Logical Link Control Group,
        3) 802.3 – Carrier Sense Multiple Access/Collision Detection Access Methods (Ethernet),
        4) 802.6 – Metropolitan Area Networking Group,
        5) 802.7 – Broadband Technical Advisory Group,
        6) 802.8 – Optic Fiber Technical Advisory Group,
        7) 802.9 – Integrated Voice and Data LAN Working Group,
        8) 802.10 – LAN Security Working Group,
        9) 802.11 – Carrier Sense Multiple Access/Collision Avoidance Access Methods (Wireless LAN’s),
        10) 802.12 – Fast Ethernet.

    b. IEEE 610.12, IEEE Standard Glossary of Software Engineering Terminology.

    c. Comply with the latest issue of several material and test standards, which have been developed and published by Network Equipment Building System (NEBS). Level 1, Level 2, and Level 3 are applicable to this Section:
        1) SR-3580: NEBS: Criteria Levels.
        2) GR-63-Core: NEBS: Physical Protection.
        3) GR-1089-Core: NEBS: EMC and Electronic Safety.
        4) GR-3160: Data Centers.

    d. Internet Engineering Task Force (IETF).

    e. International Organization for Standardization (ISO).

    f. Comply with the latest issue of material and test standard(s), which have been developed and published by Dubai Airports:

1) DA-ICTU-STD-004, Dubai Airports, Information & Communication Technology Unit, ICT Physical Infrastructure Standard.
2) DA-ICTU-STD-005, Dubai Airports, Information & Communication Technology Unit, Dubai International CAN Standard.

F. Local regulations and standards, where enforced and relevant, are to have precedence over the Standards.

1.4 DEFINITIONS AND ABBREVIATIONS

A. Definitions

1. GOOSE (Generic Object Oriented Substation Events) messaging is a mechanism defined by the IEC 61850 for the fast transmission of substation events, such as commands, alarms, indications, as messages. A single GOOSE message sent by an IED can be received and used by several receivers. GOOSE is used for example for tripping of switchgear, starting of disturbance recorder, providing position indication for interlocking. With GOOSE, one device (sender) publishes information, only the subscriber devices are receiving it. The reaction of each receiver depends on its configuration and functionality. GOOSE improves interoperability between vendors since it helps integrate IED's that are IEC 61850 compliant.

2. IED Intelligent Electronic Device, such as a PLC, protection relay or an RTU. In the context of this Specification, refers to devices that communicate by a serial protocol to the main RTU at a substation. IEDs do not communicate directly to the SCADA master station.

3. SCADA: Supervisory Control and Data Acquisition, an industrial computer system that monitors and controls a process. In the case of the transmission and distribution elements of electrical utilities, SCADA will monitor substations, transformers and other electrical assets. SCADA is used to gather and analyze real-time data. SCADA will allow for trending, graphic display, alarm tracking and reporting of data.

B. Abbreviations

1.	AI:	Analog Input
2.	AO:	Analog Output
3.	BCU:	Bay Control Unit.
4.	CPU:	Central Processing Unit
5.	DI:	Digital Input
6.	DO:	Digital Output
7.	FAS:	Fire Alarm System.
8.	GOOSE:	Generic Object Oriented Substation Event.
9.	GTI:	Guarantee Time of Intervention.
10.	GTR:	Guarantee Time of Resolution.
11.	HMI:	Human-Machine Interface
12.	ICCP:	Inter-Control Center Communication Protocol
13.	I/O:	Input and/or Output
14.	IED:	Intelligent Electronic Device.
15.	IP:	Internet Protocol.
16.	LAN:	Local Area Network.
17.	LSZH/LSOH:	Low Smoke Zero Halogen.
18.	MCS:	Master Clock System.
19.	MTTR:	Mean Time To Repair.
20.	MTBF:	Mean Time Between Failures.
21.	Node:	A network connection point. Examples include a PLC, PC, Operator Interface Terminal, Switch, Server, etc.
22.	NTP:	Network Time Protocol.
23.	PLC:	Programmable Logic Controller.

24. RTU: Remote Terminal Unit.
25. SA: Substation Automation (also denoted as SCS).
26. SCADA: Supervisory Control and Data Acquisition.
27. SCS: Substation Control System.
28. SLA: Service Level Agreement.
29. SoE: Sequence of Events.
30. SNMP: Simple Network Management Protocol.
31. UPS: Uninterruptible Power Supply.
32. ISP: Inside Plant
33. LOMMF: Laser Optimized Multimode Fiber
34. LSZH/LS0H: Low Smoke Zero Halogen
35. OSP: Outside Plant
36. SMF: Single-mode Fiber

1.5 SCOPE OF WORK

A. The Contractor shall provide, based on these specifications and design drawings, the final design and construction documents and all equipment, software, material, labor and services required to construct and install **SCADA** including, but not limited to:

1. All design services, drawings and specifications, equipment, software, materials, labor and services, not specifically mentioned or shown, which may be necessary to complete the design and installation of the **SCADA**.
2. Proposal to upgrade the specified systems to the latest technology available, so as to bring the specified items to the prevailing technology at the time of construction as detailed in Article "Quality Assurance" of this Specification.
3. Hardware as specified for the system and any hardware that is specific to the Contractor's proposed system.
4. Software application and any other software that may be required to make the system fully operational as specified including the provision of network management software, IP addresses, setup and configuration and any other required configuration.
5. Installation and setup of the system hardware and software as specified.
6. Coordination with the Service Providers of interfaced systems.
7. Integration of the **SCADA** with other systems and in coordination with the Employer.
8. Delivery of the "**Schedule of Control Points**".
9. Final connection of hardware to power, infrastructure termination and patch cords connecting system equipment to the data outlets and other network communication equipment.
10. Documentation: Licenses, Shop drawings, Specifications, As-built drawings, user's manual, operation and maintenance manuals, test reports, etc.
11. Provide list of manufacturer's recommended spare parts (along with current unit prices) for all major components in the system for two (2) years fault-free operation.
12. Provide list of manufacturer's recommended test equipment and tools (along with current unit prices) required for system maintenance.
13. Test plan.
14. System testing and commissioning.
15. System roll-out.
16. System warranty as specified herein.
17. Training as specified herein.
18. Maintenance and support as specified herein.
19. Supply the licenses for all software, programs and modules provided for the works including those developed and modified by the Contractor. The appropriate licenses supplied by the Contractor shall enable the Employer to use, modify, and develop the software, programs and modules for the works supplied under this Contract.

B. Systems Integration

1. In addition to the above scope, a Contractor handling systems integration works shall:
   a. Coordinate all integrated systems installation with the overall design.

b. Provide all additional studies to align works with other trades requirements.
c. Be in charge of the systems integration and migration of existing interfaces, as applicable.
d. Be in charge of coordination and systems integration with new systems.
e. Identify and report all required configurations for integrated applications and systems.
f. Provide and implement a proper coordination mechanism agreed upon and accepted by the end users during Project execution.
g. Provide and implement a clear execution plan for the new configurations and/or upgrades required on the integrated systems.
h. Provide documentation and submittals in compliance with Contract Documents.
i. Propose an integration strategy including a test plan philosophy, methodology and assumptions.
j. Provide for all interfaces interface control documents (ICD) signed by all involved system providers for approval to implement the described functionality.
k. Provide a fully functional test lab facility with simulation of the proposed facilities.
l. Provide all active and passive components required to perform integration within the test lab.
m. Provide a fully functional virtual environment including all necessary hardware and software to run the production of all virtualized systems.
n. Provide all additional studies in case of changes due to other systems modification related to architectural needs.
o. Be in charge of coordinating with other systems to ensure that modifications do not impact other systems and if that happens, be in charge of additional study to coordinate and propose a solution to the Engineer for final approval.
p. Carry out full coordination with the concerned parties of Local Authorities and other Contractors prior to commencing work and throughout that process.
q. Be responsible to replace and make operational all damaged equipment/accessories at his own expense, if any, which are part of ongoing contracts or other contracts, while carrying out the above specified works.
r. Provide gateways to achieve the necessary interface in-between systems along the Project Data Network. Any equipment shall have to be provided and is deemed included in the scope of work whether specifically mentioned or not, in order to ensure proper and functional integration as intended, and enable proper transfer of information in-between the systems as specified.

1.6 PRODUCTS AND WORK BY OTHERS

A. The Employer may separately purchase and/or provide certain equipment and miscellaneous items that will be installed during the course of the installation process. Such items may not be indicated in the documents. Contractor shall coordinate with the Employer and his Suppliers when considering:
1. Structured communications system cabling, termination, identification and testing.
2. Provision and installation of phone systems, computer hardware, virtual servers platform, racks/cabinets and related networking software and equipment.
3. Active communication and data processing equipment.
4. Fiber optic cabling infrastructure.
5. Provision and installation of a Virtualized Servers Environment.
6. Provision and installation of UPS in communications rooms.
7. Communications grounding busbars and grounding wires connecting to the main building earth electrode system.
8. Dedicated power panels, ground busbars, circuits, floor boxes and utility outlets.
9. Installation and finishing of plywood backboards.
10. Building mechanical ductwork, cooling/heating system and environmental control sensors.
11. Communications and electrical pathway devices both indoors and outdoors such as underground ductbanks, manholes, handholes, cable trays, conduits, conduit sleeves, and penetrations in walls and floors.

B. Accordingly, Contractor shall:
   1. Meet jointly with representatives of above systems, Contractors, Operators, Engineer and Employer to exchange information and agree on details of project implementation, equipment arrangements and interface, etc.
   2. Record agreements reached in meetings and distribute record to participants.
   3. Adjust arrangements and locations of equipment in technical rooms to accommodate and optimize arrangement and ensure necessary interface with other systems.
   4. Coordinate with the other Contractors whose deliveries are necessary for the correct operation of the **SCADA** including but not limited to the Electrical Power Systems.

1.7 CONFIDENTIALITY

A. The Contractor shall respect and protect the privacy and confidentiality of the Employer, his employees, processes, products, and intellectual property to the extent necessary, consistent with the legal responsibilities of the Employer policies.

B. Contractor shall sign a non-disclosure agreement and abide by the requirements to keep confidential all information concerning bid documents and this Project.

1.8 SUBMITTALS

A. The Contractor shall not perform any part of the work requiring submittal and review of shop drawings, product data or samples until Engineer/Employer has approved the respective submittal. Such work shall be in accordance with approved submittals:

   1. Product data: For each type of product.

   2. Shop Drawings.

   3. Wiring diagrams to show typical wiring schematics.

   4. System Operation: Include:

      a. System Architecture and performance requirements.
      b. Inter-connectivity patching of all network devices
      c. Human Machine Interface (HMI) design for all categories of users.
      d. Software Architecture and justification (e.g.: off-the-shelf and specific software, etc.).

B. Submittals shall comply with Division 01 requirements including but not limited to Sections “Submittal Procedures”, “Closeout Procedures” and “Record (As-Built) Documents”.

C. Product Certificates: signed by manufacturers of equipment and /or software certifying that furnished products comply with contract requirements.

D. Manufacturer’s Endorsement
   1. Contractor shall submit Manufacturer’s technical validation and endorsement of the design documentation and implementation.

E. Contractor shall deliver signed Warranty.

   1. Comprehensive cost structure according to committed GTI, GTR and MTBF.
   2. Maintenance stock dimensioning.
   3. Distinguish maintenance during and after Warranty period.
   4. Teams' organizations (distinguish local and remote teams, give associated manpower).
   5. Hardware repairs and software patch support procedures.

F. Testing Plan:

1. The Contractor shall provide Test Plan elaborating the testing methodologies and schedule to be applied throughout various stages of the work. This shall also include the plan for integrated tests for interface with other systems. The Contractor shall submit the Test Plan for approval by the Employer.

G. Field quality-control reports.

1. Field Test Reports: Contractor shall submit the required Field Test Reports in the format and media specified, upon completion of testing the installed system.

a. The Contractor shall test the **SCADA** after installation to ensure functionality and performance meet industry approved guidelines.

b. The Contractor shall provide and supply all necessary technical and skilled manpower, tools, test equipment, materials and transportation required for performing system and components testing.

c. Indicate and interpret test results for compliance with performance requirements.

H. Cable Pulling Plan: The Contractor shall submit a cable pulling plan, as follows:

1. Indicate the installed backbone conduit layout in schematic format, including junction boxes and distances between junction boxes.
2. Indicate contents of each conduit.
3. Indicate the cable pulling calculations, conduit fill ratios and actual cable runs and tensions.
4. Include detail and schedule showing the construction sequence of communications rooms.
5. Installation of cabling shall not commence prior to approval of the pulling plan and calculations by the Engineer.

I. Splice Plan: The Contractor shall submit shop drawings indicating the intended cable splice points, mounting method and equipment list.

J. Cable Testing Plan: The Contractor shall provide a test plan for media testing as described in "Field Quality Control" Article of this Section prior to beginning cable testing.

K. Cable Testing Reports: The Contractor shall submit cable test reports in accordance with "Field Quality Control" Article of this Section.

1. Cable Testing Reports: Submit cable test reports of performed tests as follows:

a. The tests shall clearly demonstrate that the media and its components fully comply with the requirements specified herein.

b. Three sets of electronic and hardcopy versions of test reports shall be submitted together and clearly identified with cable identification.

c. Cable inventory data shall be submitted for all fiber and copper cabling and termination equipment. Submit data electronically on CD-ROM, listing products furnished, including:

1) Manufacturer's name.
2) Manufacturer's part numbers.
3) Cable numbers.
4) Location and riser assignments.

2. Testing Equipment

a. The contractor shall deliver calibration certificates of testing equipment indicating that equipment calibration meets the appropriate levels by a qualified testing agency and that equipment has been calibrated at least once in the year prior to the testing date.

L. Product data: For each type of product.

1. Factory Tests: All equipment and cables shall be tested at Manufacturer premises, and test certificates, shall be submitted to Engineer before shipping and delivery to site.

2. Hardware including storage, computation, processor needs, operating system, display, etc. as specified for the system and any hardware that is specific to the Contractor system.

a. Submit catalogue cut-sheets /Datasheets that include manufacturer, trade name, and complete model number for each product specified. Model number shall be marked with an arrow or underlined to indicate exact selection.
b. Identify applicable specification section reference for each product performance for each component specified for approval prior to purchase and installation.
c. Submit point-by-point compliance statement to the specification, with necessary supporting documents.
d. For each product, include manufacturer's installation instructions.
e. Equipment Datasheets to include as a minimum the following:
1) Product performance and features,
2) Electrical and Environmental requirements (power supply, temperature, humidity, etc.),
3) Software and hardware releases roadmap for the next two years,
4) Troubleshooting guide,
5) Standard tests passed and results,
6) Product certificates,
7) Product compatibility matrix with other Manufacturers/Vendors.
8) Specify type of testing: in operation or in laboratory.
9) MTBF.

3. Provide a detailed Bill of Materials along with descriptive literature identifying components.

4. Drawings of equipment to be supplied shall include, as a minimum: overall dimension details for each panel, cubicle, console, etc., including internal and external arrangements and door mounted man machine interface with nameplate designations. Wiring diagrams of equipment including field device connections shall be included and specific installation/wiring requirements identified.

5. Operational Description shall include the principal functions/capabilities of the Operator workstations and PLC/ RTU as provided and configured or programmed. Include a description of system communications.

M. Software Architecture Design Document:

1. Comprehensive documentation of the expanded/modified software: a comprehensive description of all software applications and any other software that may be required to make the system fully operational as specified including the provision of network management software, IP addresses, setup and configuration and any other required configuration.

a. A software document shall be furnished for each expanded/modified software or program in the SCADA System.
b. Warranty information shall be supplied for each software or program in the System.

c. Software License information shall be submitted for each expanded/modified software or program in the system, indicating the number of licenses provided for each type of program or software and validation of the license.
d. System performance data such as mean time between failures (MTBF) and mean time to repair (MTTR) based on manufacturers' published and proven data and the Contractor's experiences with systems of a similar nature.

2. The expanded/modified Software Architecture Design document shall include, but not be limited:

a. The top-level design of the SCADA proposed software.
b. A complete description of support, interface, diagnostic, and general I/O software.
c. An inventory of major software packages, including third party, provided. A separate summary shall be provided for each major system component.
d. Illustration of the flow of data from field data acquisition to polling by the SCADA system to alarming to historical logging.
e. A description of the historical data collection subsystem, including table usage and data storage rates
   1) Polling Process, including anticipated scan rates
   2) Data consolidation techniques for use in RTU
   3) Peer to Peer data flow
   4) Hard Drive Storage space required for each software component
   5) Memory requirements (RAM) for each software component.

3. Management software datasheets to include at least the following information:

a. Product performance and existing features,
b. Known limitations (number of network elements managed, number of administrators, number of clients, size of the database, etc.),
c. Hardware requirements (storage, computation, processor needs, operating system, display, etc.),
d. Features and software releases for the next two years,
e. Standardized tests passed and results and available product certificates,
f. Product compatibility matrix with other Manufacturers/Vendors (specify level of testing in operation, lab test, declarative or theoretical).

N. Shop Drawings

1. Shop drawings submittals to cover as minimum plan views and elevations of all work to be installed.

a. Submit for approval diagrams showing layout of network components, schematic diagrams, wiring diagrams, etc.
b. Include data on electrical and physical characteristics of network components, network management system, etc.
c. Detail equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, and location and size of each field connection.
d. System Configuration as proposed with specific reference to "interoperability":
e. Include racks/ cabinets dimensions and weights required to house the system equipment
f. Include drawings for the Servers, consoles and peripheral I/O devices.
g. Show installation arrangements for all provided equipment, mounting and anchoring details, conduit entries into cabinets, and SCADA electrical power supply distribution conduit and wiring. Include data sheets and/or catalog cuts for mounting devices, anchors, wire, and other installation materials.

2. Block Diagram: Show interconnections between components specified in this Section and devices furnished. Indicate data communication paths and identify networks, data buses,

data gateways, concentrators, and other devices to be used. Describe characteristics of network and other data communication lines.

a. Include fiber optic cabling, network switches, routers, fiber patch panels and other network components.
b. Include servers, Workstations, Remote Terminal Units, transceivers, media converters, RTU's and PLC's.
c. Description of switch setup and programming to accomplish Ethernet configuration shown on the drawings.
d. Description of IP addressing scheme
e. Labeling of all components on the block diagrams.
f. Assignment of each component with a unique device identifier.
g. Show lists, ID, label and locations for all major system components.
h. Show details of interface where the facilities existing hardware interfaces with the new network

3. Wiring Diagrams: Detail specific wiring to suit Project. Coordinate nomenclature and presentation with a block diagram, and differentiate between manufacturer-installed and field-installed wiring.

4. The Contractor shall make any corrections required by the Employer or Engineer, file with him two corrected copies and furnish other similar copies as may be needed. The Engineer's approval of such drawings or schedules shall not relieve the Contractor from responsibility for deviations from drawings or specifications, unless he has in writing called the Engineer's attention to such deviations at the time of submission, nor shall it relieve him from responsibility for errors of any sort in shop drawings or schedules.

O. Calculations

1. Based on the SCADA hardware power requirements provide load calculations that will be used for planning power distribution across existing UPS systems.

P. System Graphics:

1. Provide system schematics in an approved CAD format indicating the location of monitoring and control points. Coordinate with the Electrical Contractor.

Q. Qualifications

1. The Contractor shall provide the appropriate documentation to comply with the requirements described in Paragraph "Quality Assurance", included with, and at the time of, bid submission.

R. Closeout Submittals (Record Documents):

1. The Contractor shall submit Record Documents for products and systems including but not limited to:
   a. Schematic network diagrams.
   b. Parts lists.
   c. Software and Firmware Operational Documentation:
      1) Software operating and upgrade manuals.
      2) Program Software Backup: On magnetic media or compact disk, complete with data files.
      3) Printout of software application and graphic screens.
      4) All programming and source code shall be considered as a work for hire and shall be the property of the Employer upon completion of the project.

   d. Network devices inventory.
   e. Device configuration details.

f. Device port assignments.
g. IP addressing schedule.
h. VLAN addressing schedule.
i. Layer 2 and Layer 3 protocol configurations.
j. Layer 3 routing paths.
k. Software CD's with license information.
l. Recommended list of spare parts and components to be stocked at Project site.
m. Test Reports.
n. Training Manuals.
o. Warranties.
p. Record (As-Built) Drawings.

2. Record (As-Built) drawings shall include the components and cable numbers labeled in accordance with Section "Identification for Communications Systems".

a. Utilize normal recognized drafting procedures that match Division 01 requirements.

b. Graphical symbols and component identification on detail drawings should use commonly understood, unique and unambiguous symbols (an example of such a system is IEC 60617) - to the approval of the Engineer.

c. The As-Built drawings shall incorporate all changes made to the project identified in, but not limited to, addenda, change notices, site instructions or deviations resulting from site conditions.

S. Operations and Maintenance Manuals to include:

1. Internal and interconnecting wiring and control diagrams with data to explain detailed operation and control of the equipment.
2. A control sequence describing start-up, operation, and shutdown.
3. Description of the function of each principal item of equipment.
4. Installation and maintenance instructions.
5. Safety precautions.
6. Diagrams and illustrations.
7. Testing methods.
8. Performance data.
9. Pictorial "exploded" parts list with part numbers, list of special tools and instruments indicating sources of supply, recommended spare parts, and name of servicing organization.
10. List of qualified permanent servicing organizations for support of the equipment and system, including addresses and certified qualifications.
11. System Maintenance
    a. Routine/Preventative Maintenance Schedule.
    b. Troubleshooting Guide.
    c. Breakdown Maintenance Instructions.

1.9 QUALITY ASSURANCE

A. Materials and Equipment
1. Materials and equipment shall conform to the latest issue of referenced industry standards, publications, or regulations referenced in this Section, as applicable.
2. Materials and equipment shall comply with applicable local regulations and code requirements of Authorities Having Jurisdiction. These shall have precedence over other codes and standards indicated, unless otherwise approved by the Employer, in writing.

3. Source Limitation:

a. All SCADA expanded/modified Software shall be from a single manufacturer who shall assume responsibility for the system components and for their compatibility.

b. For each category of (hardware) technology used for the SCADA infrastructure, obtain system components from one leading manufacturer who shall assume responsibility for the system components and for their compatibility.

4. Materials and equipment shall be new and shall meet or exceed the latest published specification of the manufacturer in all respects.

a. These specifications represent the prevailing technology at the time of design. However, during construction, and because the technology may be rapidly evolving, the Contractor is required to propose an upgrade of the specified systems to the latest technology available, so as to bring the specified items to the prevailing technology at the time of construction.

b. It is the Contractor's responsibility to amend, as deemed necessary, any other systems affected by the upgraded submission so as to allow for the complete and proper functionality of all submitted state-of-the-art systems, equipment and relevant products.

c. All necessary additional works that result from the upgraded materials, systems, equipment and the ancillary works are to be proposed and detailed in the shop drawings.

d. The Contractor's proposals must allow in the shop drawings for physical space, electrical/mechanical support, network connectivity and other incidental items required for the installation of the proposed updated systems and equipment.

e. The Employer shall review the proposal and shall decide whether or not such substitutions will be appropriate and prices shall be adjusted to reflect increase or decrease in cost to Employer. The cost of any change to the converged network system, the infrastructure cabling or physical plant design due to such changes shall be included in the presented cost revision prior to Employer acceptance.

5. Equipment Country of Origin
   a. Equipment Country of Origin (manufacturing country) shall be indicated in the proposal at time of bid submission. Refer to Division 01, Section "Product Requirements".

B. Manufacturer Qualifications
   1. A firm specializing in providing SCADA systems based on the IEC 61850 and IEC 60870 series Standards, similar to those indicated for this Project and with a record of successful in-service performance for at least five years prior to commencing the corresponding work for the Project .
   2. Manufacturer's systems shall be, as often as possible, a standard "off-the-shelf" package utilizing the latest hardware and software technology. Any major system development effort necessary to meet specified requirements is unacceptable. Even if this system is a new concept, it should not require huge development and shall be based on existing and proven technologies.
   3. Manufacturer or factory-authorized agency shall maintain a service center capable of providing training, parts, and emergency maintenance and repairs for overall system at Project site with a response time as detailed under "MAINTENANCE AND SUPPORT DURING WARRANTY PERIOD" Article of this Section.

C. Contractor's Qualifications
   1. Contractor with documented experience in the installation of SCADA systems based on the IEC 61850 and IEC 60870 series Standards with a minimum of 2 projects successfully executed. All projects must be of comparable size and complexity to that of this Project and

they must be verifiable and completed within the last 5 years prior to commencing the corresponding work for the Project.

2. The installer shall have at least one supervisory employee possessing a certification from the manufacturer or another recognized organization or institution, providing formal training in the implementation, configuration/programming and system diagnosis for the specified equipment.
3. The Contractor shall designate a full-time Project Manager who shall be responsible for system coordination and project scheduling, testing and commissioning and preparation of documents related to Record (As-Built Documents) and Operation and Maintenance Manuals. The Employer reserves the right to approve the Contractor's Project Manager.
4. The Contractor shall be authorized by the manufacturer of the components of the system to sell their products and initiate a Warranty service on the same items.
5. By submitting a Tender, the Contractor thereby certifies that he is qualified in all areas pertaining to, either directly or indirectly, the work. In the event the Contractor becomes unable to complete the work in accordance with the Contract Documents, or to the satisfaction of the Employer, it shall be the responsibility of the Contractor to retain the services of the applicable manufacturers' representatives to complete the work in accordance with Project schedule and at no additional cost to the Employer.
6. The Contractor shall ensure compliance with and have a thorough understanding of all local codes and contract conditions pertaining to this Project.
7. Installation team members shall have the following skills:
    a. Good knowledge of operating systems to be able to configure accurately the servers and verify their responses to critical events (power cut, disk crash, etc.).
    b. Good knowledge of database administration to be able to adjust internal parameters (redo log size, index, etc.).
    c. Implementation experience on a Project of similar size and complexity.
8. Works involving integration: Contractor shall provide evidence of previous successful integration with the proposed material made up of a combination of different brands.

1.10 DELIVERY, STORAGE AND HANDLING

A. Comply with Division 01, Section “Product Requirements”.

B. No component of the SCADA – whether software or hardware - is to be delivered to site unless it has undergone successfully Factory Acceptance Testing (FAT).

C. Test fiber optic cables upon receipt at Project site.

1. Test optical fiber cables to determine the continuity of the strands end to end. Use optical loss test set - OLTS .
2. Test optical fiber cables while on reels. Use an optical time domain reflectometer (OTDR) to verify the cable length and locate cable defects, splices, and connector; including the loss value of each. Retain test data and include the record in maintenance data.
3. Refer to, Sections:
    a. “Common Clauses for Structured Cabling”.
    b. “Communications Backbone Cabling”.
    c. “Communications Horizontal Cabling”.

1.11 PROJECT/SITE CONDITIONS

A. Environmental Conditions: Equipment shall be capable of withstanding the project environmental conditions specified under Section “Basic Electrical Materials and Methods” encountered at the installed location without mechanical or electrical damage or degradation of operating capability:

1. Interior, controlled environment.
2. Interior, uncontrolled environment.
3. Exterior environment.

B. Operational Constraints: The **SCADA** System will run 24 hours per day, all the days of the year.

C. Unless otherwise indicated, **25%** spare capacity shall be required at all levels of the **SCADA** System, including the I/O modules.

D. Power Supply

1. Power supply for all products shall be supplied or derived from the voltage system described below, as shown on the Drawings, or as otherwise specified.

2. Nominal characteristics of power supply and distribution system (AC voltage / No. of Phases / Frequency / Earthing system) shall be as per local country standard. For details, refer to Section "Basic Electrical Materials and Methods".

1.12 WARRANTY

A. Special Warranty
1. The **SCADA** System (comprising any associated hardware and software) shall be warranted by the Manufacturer to be free from defects in equipment, software and workmanship for a period defined below in paragraph "Warranty Period".
2. Manufacturer's Warranty: Provide written warranty, signed by the Manufacturer and the Installer agreeing to replace system devices and equipment that fail in materials or workmanship and to provide software patch support and updates within specified warranty period.
3. To maintain the manufacturer's warranties, equipment shall be installed, commissioned and serviced by those installers authorized by said manufacturer to perform those duties. If the Contractor is not authorized, by the said manufacturer, it is his sole responsibility to make the appropriate arrangements and bear all cost and consequences thereof.
4. All manufacturers' equipment warranties shall be activated in the Employer's name and shall commence on the date indicated in paragraph "Warranty Period" below.

B. Experimental Period
1. There shall be an Experimental Period during which the Contractor shall undertake supervision and responsibility for operation of the system under actual site conditions. If any malfunction or degradation in the performance is noted on the system during this period, it shall be attended to immediately.
2. During this period, the Contractor shall fully demonstrate the system performance under actual operation conditions. This demonstration is to confirm, to the satisfaction of the Employer/Engineer, that the system is free of remarks and is ready for taking over.
3. The Experimental Period shall extend over three months and shall start following the certification by the Engineer of the successful testing and commissioning of the system. The Experimental Period shall, each time a malfunction is detected, be extended by three months starting from the certification by the Engineer of the successful testing of the system following the rectification of the malfunction.

C. Taking Over of the System
1. The system shall be considered ready for taking over by the Employer following:
   a. The expiry, with no malfunctions being detected during the last three months, of the Experimental Period (as may be extended), and
   b. The submission by the Contractor, and approval by the Engineer, of the documents and information required from the Contractor for the use, occupation and maintenance of the system in accordance with the Contract (updated as necessary to reflect any rectification(s) introduced during the Experimental Period).

D. Warranty Period
1. The Contractor shall include a statement of warranty on the entire system and on the individual pieces of equipment for two years from the date of taking over of the system.

2. During the Warranty Period, the Contractor shall undertake Maintenance actions as defined in the "MAINTENANCE AND SUPPORT DURING WARRANTY PERIOD" Article below.
3. During the Warranty Period, the Contractor shall provide all equipment, material, software and labor needed to replace or repair defective products without any additional cost to the Contract.
4. Warranty period shall be revised in accordance with Division 01, Section "Product Requirements" depending on Equipment Country of Origin.

1.13 MAINTENANCE AND SUPPORT DURING WARRANTY PERIOD

A. Support
1. The Contractor shall offer a comprehensive explanation of its Service Level Agreement (SLA) policy. The SLA should cover at least the following performance terms:
   a. 99.999% availability. GTI and GTR should be guaranteed accordingly.
   b. Emergency level 24/24, 7/7 phone support shall be available. Distant intervention on system shall be offered.
   c. High-level problem investigation support shall be offered 5/7 during working hours.
   d. Maintenance stocks shall be properly sized by the Contractor in order to match operational quantities replacement needs based on Manufacturers MTBFs for each component within the network.
   e. The MTTR shall not exceed 30 minutes. The MTTR shall include the diagnostic time, active repair/replacement time and the adjustment/testing time on site, but shall exclude the response time.
2. Maintenance service shall include:
   a. Contract lifetime software patching for revealed problems during operations.
   b. Contract lifetime hardware replacements on established malfunctions or weaknesses generating repetitive loss of service quality.
   c. Following receipt of a defective product, Manufacturer shall make reasonable efforts to repair or replace equipment with new ones and return the equipment within a reasonable time not exceeding four working days.

B. Maintenance Service
1. During the Warranty Period, Manufacturer or factory-authorized agency shall maintain a service center capable of providing spare parts and emergency maintenance and repairs for the overall system at Project site 7 days a week and 24 hours a day. Competent personnel shall be dispatched to rectify stoppages at any time during the day or night when being called on by the Employer.
2. The Contractor shall submit a Service-Call Report to be sent to the Employer immediately following every call out, indicating the time of call out visit, cause, remedial action taken and the time that the service was restored.
3. A Maintenance Manpower Plan shall demonstrate the Contractor's committed resource level available for all types of activities to be carried out within the Warranty Period. Such a plan shall be submitted for Approval six months before commencement of the Warranty Period.
4. The Contractor's response time, during the Warranty Period, shall not exceed 1 hour. The response time is defined as the time that elapses between the reporting of a fault and the maintenance personnel arriving at where the faulty equipment is located.
5. During the Warranty Period, the MTTR shall not exceed 30 minutes**.** The MTTR shall include the diagnostic time, active repair/replacement time and the adjustment/testing time on site, but shall exclude the response time.
6. During the Warranty Period, the monthly average of the Repair Time shall be lower than or equal to 6 minutes for each device. This performance will be monitored.
7. The Contractor shall provide at least four inspection visits at six-month interval during the Warranty Period. The Contractor shall submit a Service-Call Report to be sent to the Employer immediately following every inspection visit, indicating the time of call out visit, cause, remedial action taken – if any - and the time that the service was restored.

8. The Contractor shall be responsible for clearing away from the Site all surplus materials, rubbish, temporary works of every kind and leaving Project Site and installation clean and in a workmanlike condition to the satisfaction of the Employer, upon completion of repair, and maintenance works.

C. Maintenance Performance Data
1. Updates
   a. The system will have to be conceived to facilitate the updates that will take place throughout its life. Software update process must be easy, rapid and without risk, and must be reversible.
   b. Update shall be transparent to the user and shall be done without interruption of the service.
   c. Starting with installation of the SCADA system and continuing until 10 years after Final Acceptance, the Contractor, upon authorization from Engineer, shall provide, install, test, and commission updates to the SCADA system software and computer provided software within 15 days from when such updates are announced and released by the manufacturer.
   d. All updates shall be provided which are necessary to maintain the SCADA system in compliance with the Contract Documents, as well as any incremental releases.
2. Corrections
   a. In the event of error, the system shall have, as soon as possible, to store in a file a certain amount of information allowing the correction of this error, e.g. entries in the database, faulty operations of the statistics, etc.
3. The Contractor commits himself to the three (3) main sizing data of maintenance:
   a. Annual number of hours of preventive maintenance.
   b. Annual number of hours of corrective maintenance.
   c. Average Annual cost of spare parts (Average based on ten years).

D. Preventive Maintenance
1. The Contractor shall describe the selected operations for preventive maintenance as planned during daily operation.
2. All preventive maintenance procedures shall minimize disruption of the live system operation. No preventive maintenance procedure shall be allowed to jeopardize the Operators ability to monitor and control system operation. At the Operators option, their maintenance personnel may participate in any preventive maintenance procedure.

E. Curative Maintenance
1. The selected operations shall be chosen to correspond to a significant fraction of the forecasted time devoted to curative maintenance.
2. For each defect incidence, the Contractor shall record:
   a. Equipment identification.
   b. The object of the Maintenance activity.
   c. The type of Maintenance activity (planned or not).
   d. The total man-hours spent for the activity.
   e. The total down-time duration ascribable to the Maintenance activity (transportation time, diagnosis time, repair time, restart time).

1.14 SPARE PARTS AND EXTRA MATERIAL

A. Contractor shall handover manufacturer's recommended spare parts for all major components in the system for two years fault-free operation.

B. The manufacturer shall guarantee the flow and availability of the spare parts without a major design change for at least ten years' period from date of System Acceptance by Employer.

C. Handover manufacturer's test equipment, tools, licensed software, diagnostic software, laptop, interface cables, etc., required for normal routine inspection and maintenance and testing of system components as appropriate for equipment supplied.

PART 2 - PRODUCTS

2.1 STANDARD COMMERCIAL PRODUCTS

A. Refer to Division 01 Section 016000, “Product Requirements”.

2.2 OVERVIEW OF PROPOSED POWER SUPPLY SYSTEM

- Load Categories
- Power Supply Network
- Power Supply Source
- Control and Monitoring

A. Load Categories: The electrical distribution system for the various Airport facilities will be split into four categories listed in decreasing order of priority:

1. Category 1: Emergency (UPS) Loads that cannot tolerate power failure: includes IT and communication systems, emergency lighting and illumination of means of egress.

2. Category 2: Emergency (Life Safety and Critical) Loads: includes Fire pumps, Staircases pressurization fans, Smoke Management System, PLB’s fire fighters elevators, etc.

3. Category 3: Essential Loads: includes central battery system, UPS units (of Category 1 loads), walk-in refrigerators, freezers, etc.

4. Category 4: Normal (Non-essential) Load: fed directly from the DEWA grid: includes chillers, air conditioning, general lighting, conveying systems, etc.

B. Control and Monitoring:

1. A SCADA system is already existing for the supervision and control of the existing 11kV power distribution network, and downstream up to the Main LV Switchboards. The existing SCADA system shall be expanded and modified for the supervision and control of the new 11 kV Substations.

C. SCADA Control Centers:

1. A SCADA system is already existing at the Airport Control Center / Master Station and at JAAC Substation Control Center.

2. The Contractor shall collect the as-built drawings of the existing SCADA system. The Contractor shall expand/modify the existing SCADA system and add necessary equipment as deemed necessary to have a fully operational SCADA system:

2.3 KEY FEATURES

A. Key features of the SCADA shall include but shall not be limited to:

1. Full monitoring, diagnostics and control of designated MV and LV network components:
   a. 11kV Switchgear.
   b. 11kV Main Ring Units.
   c. 11/0.4kV distribution transformers.
   d. Low Voltage Main Distribution Boards.

2. Automatically reconfigure and maintain the distribution network.
3. Reconfigure the MV loop in case of phase earth fault.

4. Data acquisition for metering devices, sensors, and other intelligent electric devices
5. Recording of events, Operator actions and measured values.
6. User-composed measurement groups for displaying real-time and historical trends.
7. Power quality analysis (including harmonics, voltage sags/swells, transients and voltage and current sinusoids).
8. Power quality compliance reporting for international standards (IEC61000 4-30; EN50160)
9. Supervise servers, PLC/HMI/RTU communication links and connected workstations status.
10. Flexible filtering of events, alarms and historical data.
11. Graphical displays of information.
12. Reporting tools with standard report templates.
13. Use open system and standard communication protocols.
14. Interoperability with BCU's and Intelligent Electronic Devices IED's including intelligent digital protection relays and metering system.
15. Dual redundant and hot standby system components support.
16. IP-Networking system for SCADA communication.
17. Web-based secure access.
18. System Security: the system shall provide a comprehensive system security policy to prevent un-authorized access to the system.

B. Network Security

1. Network security should be inherent/built-in at all levels of the network. Steps for securing the network and providing reliable operations consist of, but are not limited to:

    a. Physical Access: Limit and track physical access to all network and server elements.
    b. Virtual Access: Limit, authenticate and track access to every network device and server.
    c. Logical Network Separation: Create subnet boundaries between sub-system networks, servers, control rooms, etc.
    d. Perimeter Security: Enforce a stringent perimeter security strategy, using network filters and firewalls, to limit and track all traffic between the Internet, intranets and user sub-systems, servers and Control Rooms.
    e. Virus Scanning and Host Security: Use a comprehensive virus scanning and server/application security policy.

2. The overall SCADA data communications network shall be dedicated to the SCADA and shall be independent of the Airport Data Communications Network.

C. For details of input/output points to and from major electrical equipment,".

2.4 SYSTEM ARCHITECTURE

A. System architecture shall allow communication between Bay Control Units (BCU's), intelligent electrical devices (IEDs) and the SCADA, including the supervisory servers and consoles.

B. The proposed solution shall utilize the latest standards and technologies, such as IEC 61850 client-server communications, GOOSE messaging, fiber optic networks, and complete redundancy.

C. The SCADA system shall be:
1. scalable to adapt to the planned and potential evolution of the site(s)
2. modular to enhance performance
3. redundant to provide reliability to match requirements
4. able to meet the performance requirements.

D. The SCADA system shall allow for Distributed Architecture to support varied amounts of data points by supporting multiple:
1. I/O servers to maintain high data acquisition performance
2. alarm servers to maintain high alarming performance
3. trend servers to maintain high historical logging performance

E. The SCADA system shall allow for System Redundancy to limit and minimize the impact of any component failure or maintenance. Redundancy shall cover the following components:
   1. primary and standby I/O servers
   2. network: multiple topologies (such as star or self-healing ring) and redundant distribution
   3. serial line: gateway and device dual port attachment
   4. programmable logic controllers (PLCs)

F. Redundancy of the SCADA system components referenced herein shall mean when a component fails for any reason, a “hot” standby unit of identical functionality shall automatically take over and an alarm will annunciate. Transfer shall be “bumpless” so control will continue uninterrupted. “Hot Standby” is a method of redundancy in which the primary and secondary (i.e., backup) systems run simultaneously. The data is mirrored to the secondary system component in real time so that both systems contain identical information.

G. Data Acquisition and Network Topology
   1. A series of standard bays panels shall be interconnected by an open protocol. A bay is a feeder, a transformer, a coupler or a capacitor bank. A standard bay panel contains the IED's needed for the local control and protection of the bay.
   2. Each IED shall have its own integrated Ethernet switch.
   3. Each bay shall have a local/remote switch enabling or disabling the local control.
   4. A Gateway (PLC/RTU Controller with built-in Ethernet switch), shall provide the interface between the substation and the remote SCADA control center using the protocols: IEC 60870-5-101 or IEC 608670-5-104.
   5. Each bay shall have an autonomous behavior, i.e. local control and interlocking, sequence of events, etc. It is to be connected to other bays by logical means for system wide functions, such as interlocking or busbar protection, but can have a downgraded mode with complete protection and control of the local bay. Its functioning shall not be affected by any fault occurring in any of the other bay control units of the station.
   6. An operator interface (HMI), shall provide the local supervision and control of the substation, sequence of events, archiving, printing, etc. It shall be active when the substation is in local mode.
   7. The communication protocol within the Substation shall be IEC 61850 in order to permit 100 Mbps peer-to-peer Ethernet communications over the substation internal dual fiber optic loop: the Substation Control System (SCS).
   8. Additional gateways may be required to interface legacy field bus communicating IED's and the IEC61850 substation bus. The protocols may be serial or TCP/IP versions for IEC 60870-5, DNP3.0 and Modbus.

H. Control Levels
   1. The network architecture shall allow the implementation of different levels of control:
      a. Local (at the IED level)
      b. SCS (at the substation level) and
      c. SCADA (remotely from SCADA Control Center).

2.5 PERFORMANCE REQUIREMENTS

A. The following minimum performance requirements shall be met:
   1. System loading and utilization:
      a. Utilization of any processor
         1) 30% under normal activity state
         2) 70% under high activity state
      b. Utilization of any memory device:
         1) 30% under normal activity state
         2) 70% under high activity state
      c. Utilization of any communication device of network bus:
         1) 40% under normal activity state
         2) 80% under high activity state
   2. Response Times:

a.	Display appearance	< 1 sec
b.	Presentation of binary changes	< 1 sec
c.	Presentation of analog changes	< 2 sec
d.	From order to process output	< 1 sec
e.	From order to update of display	< 2 sec

B. The accuracy for measuring values, from transducer input to the indication on the display of the SCADA system, shall be better than or equal to 1%.

C. The System shall utilize the following Communication Protocols:

1. IEC 61850: for networked communication within the substation (substation automation).
2. IEC 60870-5-101: for remote communication and connection to control center: Standard master/remote SCADA functionality over fixed lines
3. IEC 60870-5-104: for remote communication and connection to control center: Standard master/remote SCADA functionality using TCP/IP over Ethernet.
4. IEC 60870-6 or ICCP (Inter-control center protocol): for all required bidirectional communications functionality for inter-control center communications.

D. The SCADA System functions shall include full support of the following communication protocols:

1. Modbus TCP/IP, including time-stamped data and waveform formats
2. SNMP protocol (v1 and v2)
3. DNP3
4. IEC61850
5. IEC 60870-5-104
6. OPC DA exchange (v1, v2 and v3)
7. OPC AE exchange

2.6 CONTROLLER (PLC/ RTU)

A. The hardware of the Controller shall be based on a flexible, modular, multi-processor architecture, with dual processor (CPU's) including local database, multiple external communication ports using open protocols, process I/O handling. Flexible and expandable input/output (I/O) modules/cards.

B. The design of all hardware shall be such as to ensure satisfactory operation in an electrically hostile environment typical of high voltage electrical installations. In order to prevent incorrect functioning or damage to the equipment when subjected to interference arising from power system switching, fault currents and lightning, all input and output circuits, and power supply circuits shall be provided with isolation and/or immunity to electrical interference. The Contractor shall state how this is achieved and the international standards to which the PLC/ RTU has been tested in this respect.

C. The Contractor shall submit the detailed arrangement specifying the used modules at each Substation / Generator Plant for Engineer's review and approval.

D. Each Controller (PLC/ RTU) shall be of modular type typically consisting of the following modules:
1. Processor module
2. I/O Modules
3. Communication Module
4. Power supply unit

E. Redundant Processor Module:

1. Capable of automatic restart in the event of power failure without loss of functionality or local database. Configuration / parametric set-up data, which may be programmed on site or via download, shall be stored in non-volatile memory that does not rely upon battery support.

2. Readily possible to update the software to alter to extend its functionality.

3. The module shall be provided with the following features as minimum:
   a. Dual (redundant) CPU
   b. Min. 64 MB RAM
   c. Min. 8 MB FLASH
   d. Clock frequency 122 MHz or higher
   e. Two Ethernet ports (RJ45).

4. The dual redundant CPU's shall operate in hot standby configuration mounted in individual chassis (including exclusive power supply modules) and separate cubicles.

F. Input/Output Modules

1. The standard I/O shall include single point, double point, multi-point and pulse counting digital input signals, analogue input signals and command output signals, The I/O modules shall include all interface and protection circuits. It shall be possible to interchange I/O modules without powering down the Controller, i.e. modules shall be 'hot swappable'.

2. All Controller analogue and digital inputs and outputs shall provide 2kV isolation between field circuits and the Controller internal circuitry. Analogue inputs and outputs shall withstand 100 V RMS 50 Hz common mode for 1 minute.

G. Analogue Input Modules

1. Analogue input modules are required for the continuous monitoring of analogue measurements. The analogue inputs can be configurable from a downloadable database.

2. The elementary input data from the analogue I/O (currents and voltages) together with the switchgear status information shall be used to derive by calculation in the Controller the following power system measurements for each circuit:
   a. Voltage (kV)
   b. Current (Amps)
   c. Active Power (kW)
   d. Reactive Power (kVAr)

3. The Controller shall report analogue values when they change by a significant amount for at least a preset period with the reporting value limits and period being user-definable within the downloadable Controller database.

4. It shall be possible to link analogue inputs to the Controller through standard protocols, using other modules.

5. The Controller shall also be able to block an input if it detects the input value is fluctuating excessively. The limits defining the acceptable fluctuation limits shall also be user-definable. The Controller shall automatically unblock input if the behavior of the input returns to within the acceptable limits.

6. Each analogue input shall be terminated with transient voltage protection components. In case of overload, the input circuit shall not sustain any deterioration of its characteristics. Furthermore, an overload present on one of the circuits shall not induce telemetry errors on any other circuit.

H. Digital Input Modules

1. Status and alarm input information is to be supplied from voltage free contacts. These contacts may open or close to register the specified status or alarm. Each input shall be individually software configurable from a downloadable database to register the specified status in either case.

2. The Controller shall provide the interrogation voltage to monitor these contacts. This voltage shall nominally be in the range 24 to 60 V DC and the interrogation circuit current shall typically be in the range 5 to 20 mA.

3. Status changes shall be time tagged to a resolution of 1 milli-seconds. Digital inputs may be either single point, double point or multi-point.

4. The interpretation of states for single or double point inputs shall be configurable. A single point indication shall be represented by a binary digit. Double points shall be represented by a pair of binary digits.

5. A status change or alarm shall only be reported if the input state has changed for longer than a user defined period of time within the downloadable database. This period shall be adjustable for each point from 10 milli-seconds to 300 seconds.

I. Digital Output Modules

1. Digital outputs are required to operate items, either directly or via auxiliary relays, dependent on the load presented by the plant equipment. Outputs shall be provided in the form of interposing relays with normally open voltage free contacts that will form the initiating elements in the above control circuits. It shall be preferable that the interposing relays be located on the digital output modules.

2. Each digital output module shall be configurable between persistent and pulse output modes. In persistent mode, the digital output shall be set to a particular state and remain there until set to the opposite state. In pulse mode, the digital output is set to the energized state for a predefined time. The time, typically 500 milli-seconds shall be user configurable for each pulse mode output within the downloadable database.

J. Communication Modules

1. The Controller shall be able to communicate with the system servers on a main and alternate channel using a variety of open protocols.

2. The Controller shall support IEC 61850 GOOSE messaging.

3. The Controller shall be capable of being remotely accessed over the Project redundant IP data communications network.

4. Downloading information to and uploading from the Controller shall not have a significant impact on the performance of alarm, event reporting or command execution.

5. Several communication media must be offered:
   a. Ethernet through RJ 45 ports.
   b. RS-232
   c. RS485
   d. 20mA current loop
   e. Any other Communication Module required in the Project.

K. Power Supply Modules

1. The Controller shall be powered either from 24 VDC battery backed power supply or from a battery and charger provided under this Contract, as specified below. With this power supply, the Controller shall be capable of operating with supply variations of between +15% and -15% of nominal voltage when subjected to voltage fluctuations.

2. The Controller shall be equipped with two power supply modules, each capable of catering to 100% of the Controller load.

3. Protective Circuit IEC Class/Category: determined by the energy coordination study carried out between Surge Protection Devices (SPDs') installed at different levels of the distribution and communication systems.
   a. Surge suppression and isolation circuits shall protect the Controllers against external electrical disturbances. Over voltage and under voltage protection shall also be provided to prevent Controller internal logic from being damaged and to prevent the Controller internal logic from becoming unstable or to mal-operate due to voltage fluctuations.
   b. Comply with Section "Surge Protection for Low-Voltage Electrical Power Circuits".

L. Terminal Blocks

1. Terminal blocks shall be having provision for disconnection (isolation), with full-depth insulating barriers made from moulded self-extinguishing material.

2. All terminal blocks shall be suitably arranged for easy identification of its usages such as CT (Current Transformer) circuits, PT (Potential Transformer) circuits, analog inputs, status inputs, control outputs, auxiliary power supply circuits, communication signals etc.

3. Terminal blocks for CT circuits shall have feature for CT shorting (on CT side) & disconnection (from load side) to facilitate testing by current injection. Similarly, terminal blocks for PT circuit shall have feature for disconnection to facilitate voltage injection for testing.

4. Terminal blocks shall be appropriately sized and rated for the electrical capacity of the circuit and wire used. No more than two wires shall be connected to any terminal. Required number of terminal blocks shall be provided for common shield termination for each cable.

2.7 HUMAN MACHINE INTERFACE (HMI)

A. Description: Microprocessor-based, self-contained device mounted on the door of the control modules cubicle and arranged to display parameters values. Features include the following:

1. Touch screen Size 10 inch, 800x600 pixels resolution, 64,000 color TFT screen able to display graphics with function keys.

2. Display alarms and events from any Controller and have the ability to manage it from the panel.

3. Selected for status and parameter display by programmable designations.

4. Status and trip rating are to be displayed in addition to parameter values.

5. Nonvolatile memory retains programmed input data indefinitely during power outages.

6. Provided with RAM memory 64 MB minimum and flash memory.

7. The display features, type and size shall satisfy the Employer requirements if any.

2.8 INDUSTRIAL ETHERNET SWITCHES

A. The Contractor shall provide, as deemed necessary, dual Ethernet switches at each Control Room / Network Node with the following minimum requirements:

1. Modular, managed, industrial backbone switch, 19" rack mounted with Layer 3 functionality.
2. Port Type and Quantity: 24 ports of wire speed 10/100/1000 Mbit and802.3af (PoE), and 8 Gigabit SFP slots.
3. SFP Fiber Optic Transceiver Characteristics:
    a. Minimum link budget of 26 dB at 1550 nm
    b. Port Type: 1000BASE-LX
    c. Single Mode (9/125 μm)
    d. Allowable losses:
        1) Splicing losses: 0.3 dB at each splice
        2) Cable attenuation losses: 0.25 dB/Km
        3) Insertion losses: 0.5 dB at each end
        4) Link power penalties: 3.3 dB
4. Power supply unit: Dual power supplies, a hot swappable fan tray with redundant fans, and hot-swappable line cards.
5. Fiber Optic patch panels with their corresponding patch cords interfacing the SCADA system network main dual redundant ring shall be provided by the Contractor at each control room.
6. Management:
    a. Single console port and single IP address to manage all system features
    b. Software configuration management, including local and remote storage
    c. Simple Network Management Protocol (SNMP) Versions 1, 2, and 3 instrumentation, delivering comprehensive in-band management
    d. CLI-based management console to provide detailed out-of-band management
    e. Remote Monitoring (RMON) software agent to support four RMON groups (history, statistics, alarms, and events) for enhanced traffic management, monitoring, and analysis
    f. SPAN ACL filtering
    g. SPAN CPU port
    h. Static IP configuration
    i. Enhanced SNMP MIB support
    j. HTTPS
    k. Time Domain Reflectometry (TDR)
    l. MAC Address Notification
7. Industry Standards:
    a. Ethernet: IEEE 802.3, 10BASE-T
    b. Fast Ethernet: IEEE 802.3u, 100BASE-TX, 100BASE-FX
    c. Gigabit Ethernet: IEEE 802.3z, 802.3ab
    d. IEEE 802.3af PoE
    e. IEEE 802.3 ad LACP
    f. IEEE 802.1d CoS prioritization
    g. IEEE 802.1Q VLAN
    h. IEEE 802.1x user authentication
    i. 1000BASE-SX
    j. 1000BASE-LX/LH
    k. 1000BASE-ZX
    l. RMON I and II standards
8. Diagnostics: LED's, log-file, syslog, signal contact, RMON, port mirroring, topology discovery 802.1AB, disable learning
9. Security: Port security (IP and MAC), SNMP V3. (no encryption). Redundancy functions: Ring structure, MRP (IEC-ring functionality), RSTP 802.1D/w, redundant network/ring coupling, redundant 24 V power supply

10. Services: QoS 8 classes, prioritization (IEEE 802.1D/p), VLAN (IEEE 802.1Q), multicast(IGMP snooping/querier), multicast detection unknown multicast, broadcast limiter, fast aging
11. Routing: Static routing, VRRP router redundancy, layer 3 - ACL,
12. Operating temperature: -10º to +50ºC
13. Storage/transport temperature: -40º to +70ºC
14. Relative humidity (non-condensing) and Seismic Loads: In accordance with Article "Project / Site Conditions" of this Specification.
15. Mounting: 19" Cabinet
16. Protection class: IP20

B. Switches shall ensure that networking will not cause collisions with the overall network.

2.9 NETWORK MANAGEMENT EQUIPMENT

A. General

1. System Architecture shall be based on a "Client-Server" configuration.

2. System software shall be controlled and configured by working parameters stored in tables and easy to change without programming.

B. Servers

1. The Contractor shall design Servers architecture to fulfil, as a minimum, the following requirements:
   a. Dual-redundant servers in clusters for high availability.
   b. Servers located in separate rooms for disaster recovery.
   c. The system shall support multiple:
      1) I/O servers to maintain high data acquisition performance
      2) alarm servers to maintain high alarming performance
      3) trend servers to maintain high historical logging performance

2. The Contractor shall design servers that are able to cope with the foreseen workload:
   a. The Contractor shall indicate the percentage increase of workload that the servers will be able to cope with.

3. The Contractor shall deliver and configure the required servers.

4. Minimum requirements of Servers shall be confirmed by the relevant manufacturer/supplier and shall comply with:
   a. Section "Computers & Related Peripherals".

C. End Users' Clients

1. The Contractor shall provide requirements for workstations for operation by the Employer.

2. Main characteristics shall be given in terms of Memory, CPU, Screen size, resolution, etc.

3. The Contractor shall configure the required workstations.

4. The following peripheral I/O devices shall be provided at the workstations and terminal/data servers:
   a. Keyboard and mouse
   b. Flat panel video display unit.

5. The intent is to have all Computers and related peripherals purchased independently of the systems they serve. Coordinate with Employer for recommended technical requirements and required quantities.

D. Network Time Protocol (NTP) Clock

1. Time synchronization shall be ensured by a time server broadcasting messages compliant with Network Time Protocol (NTP). All equipment delivering time-stamped data shall take into account these messages.

2. The times at all nodes on the SCADA, including the Servers, shall have their real time clocks updated by this NTP clock every 24 hours at minimum.

3. Provided with the appropriate architecture, the SCADA shall maintain time synchronization between IEDs, PLCs, and the system I/O servers.

4. The system shall be capable of integrating with a GPS receiver for global time synchronization.

5. The NTP server shall similar to that specified under Section “Master Clock System (MCS)”.

2.10 SCADA SYSTEM SOFTWARE

A. The Contractor shall expand and modify any existing software in the Control Centers / Master Stations to include all the additional substations and RTUs

2.11 OPERATOR WORKSTATIONS

A. The Contractor shall expand and modify the existing operator workstations in the Control Centers / Master Stations to include all the additional substations and RTUs

B. The Operator workstation shall comprise industrial Console-mounted PC’s and associated peripheral Operator I/O devices, located at the Control Room.

C. Provide an alarm to uniquely identify a PC communication failure.

D. All PC’s shall be the latest model at the time of purchase and shall be sourced from a recognized manufacturer. Purchase of the PC’s shall be delayed until the latest time possible without causing a delay in the construction schedule to ensure that they will be state-of-the-art, based on the latest proven technology.

E. All PC’s shall be suitable for rugged and continuous operation.

F. The workstation specifications shall be according to the SCADA System manufacturer requirements and shall comply with , Section “Computers & Related Peripherals” **.**

G. Refer to Article “Network Management Equipment” of this Specification Section.

2.12 PRINTERS

A. The Contractor shall expand and modify the existing printers in the Control Centers / Master Stations to include all the additional substations and RTUs

B. Alarm Printers

1. The alarm printer shall meet, at minimum, the following specifications:
    a. Minimum print speed of 300 characters/second. Slower speed printers shall not be acceptable when printing in normal quality.
    b. Selectable character sizes.
    c. Sprocket paper feed.
    d. Top-of-page, skip and tab control.
    e. The printers shall accept continuous fan-fold paper with a width equivalent to A3 size (297 mm by 420 mm).
    f. Constructed for heavy duty-cycle environment.
    g. 24 x 24 dot matrix printer.

C. Report Printers

1. The report printer shall meet, at minimum, the following specifications:
    a. Minimum print speed of twelve pages per minute black and three pages per minute color. Slower speed printers shall not be acceptable when printing in normal quality.
    b. Scalable fonts.
    c. Single or double bin paper trays, capable of printing A3 size (297mm x 420mm) and A4 size (210mm x 297mm).
    d. Page feed and page discharge controls.
    e. Color and black/white printing capability without changing ink or toner cartridges.
    f. 1200 dpi black and white and 600 x 300 dpi color.
    g. Laser jet technology.

2.13 OPERATOR DISPLAY UNIT

A. The Contractor shall expand and modify the existing operator display unit in the Control Centers / Master Stations to include all the additional substations and RTUs

B. LED, 20 inch, complying with, Section “Digital Media Displays”.

C. Refer to Article “Network Management Equipment” of this Specification Section.

2.14 MASTER DISPLAY UNIT

A. The Contractor shall expand and modify the existing master display unit in the Control Centers / Master Stations to include all the additional substations and RTUs

B. LED, 103 inch display with the following specifications as minimum:
1. Aspect ratio: 16:9.
2. HD resolution.
3. Brightness: 1,000 cd/m2.
4. Contrast Ratio: 5,000:1.
5. Gradation: 5,000:1.
6. PC Signal Compatibility: VGA, WVGA, SVGA, XGA, WXGA, WXGA+, SXGA, SXGA+, WSXGA+UXGA, WUXGA.
7. Supported Video Standards: NTSC, PAL, PAL 60, SECAM, Modified NTSC.
8. Input / Output: Mini D-sub 15pin x 1 (Female) Analog RGB/Components Plug & Play (VESA DDC 2B), M3 jack x 1, D-sub 9-pin x 1(Male) External control, RS-232C compatible RCA pin jack x 2(L/R), HDMI x 2, BNC x 3 Analog RGB / Component, RCA pin jack x 2.

C. Refer to Article “Network Management Equipment” of this Specification Section.

2.15 CUBICLES

A. As a part of local control system, cubicles shall be provided to house the Controllers, RTUs, PLCs, I/O modules, etc; other cubicles shall be provided to house wiring terminals between the previously mentioned cubicle and the field devices.

B. The cubicle shall consist of steel frames with vertically arranged terminals and terminals strips and covered channels for cables and interconnecting wires.

C. Potential-free contacts shall be provided on all equipment to permit the repetition of appropriate indications, alarms and controls by telemetry to a remote control center.

D. The dimensions of the cubicles shall not exceed (2200 x 800 x 800) (H x W x D) mm.

E. Cubicles shall be provided with hinged front and rear doors.

F. Cubicles shall be free standing, constructed from sheet steel.

G. Cubicles shall be designed to comply with degree of protection IP 54 and shall be vermin and termite proof. The bottom of the cubicles shall be sealed, provided with base-plates and cable-entry glands.

H. Cubicle doors shall be of the lift off type and shall be provided with sealing gasket on the rim to ensure tight closure. Doors shall be secured with integral handle provided with lock. All cubicle door locks/handles shall be of the same design and construction.

I. Cubicles shall be provided inside with a lamp operated by a door switch, suitably positioned to ensure an even illumination of the entire cubicle.

J. Cubicles shall be provided with a cooper earth bus bar.

K. In the event of the air conditioning system failure in the control and relay room the equipment must remain operational at full load, and at the ambient temperature of the 50 Deg. C and 100% relative humidity. In that case any condensation and overheating must be prevented by anti-condensation heaters controlled by one hygrostat and thermostat and ventilation fans. **Consideration shall be given to the use of Self-Cooled cubicles using integrated air-conditioners, to the approval of the Engineer.**

L. All equipment installed on the front of the cubicles shall be flush mounted. The arrangement of the inside equipment shall allow easy access to any part and shall be fixed on brackets.

M. Circuit labels shall be provided on the outside and the inside of each cubicle.

N. Where rack, cabinet, or console mounting is indicated, equipment shall be designed to mount in a 19-inch (483-mm) housing complying with ECA TIA/ECA-310-E and Section “Communications Equipment Room Fittings”.

2.16 SIGNAL TRANSMISSION COMPONENTS

A. Provide a dual redundant dedicated fiber optic network and Ethernet switches for the automation system communications as specified herein.

B. Comply with the following Specification Sections – as applicable to power, control, data and video signal transmission cables:

1. Section “Low-Voltage Electrical Power Conductors and Cables.”
2. Section “Communications Backbone Cabling.”

3. Section “Communications Horizontal Cabling.”

C. Low Smoke Zero Halogen (LS0H) cables: for plenum installation as per adopted Standards for the Project.

1. Low Smoke Zero Halogen (LSZH/LS0H) cables shall comply with the following standards:
   a. Flame retardant: IEC 60332-1.
   b. Halogen-free according to:
      1) IEC 60754-1 for amount of halogen acid gas.
      2) IEC 60754-2 for corrosiveness of combustion gases according to (degree of acidity).
   c. Low smoke density according to IEC 61034-2.

D. Fire Resistant Cables: For life safety installations interface. Refer to Section "Low-Voltage Electrical Power Conductors and Cables".

1. Use Fire-resistant cables Type FR4.

E. General Cable Requirements: Size and type as recommended in writing by system manufacturer unless otherwise indicated.

F. Cables for all field level installations shall be screened and sheathed with anti-termite / rodent PVC.

G. Grounding Components: Comply with requirements in Section "Grounding and Bonding for Electrical Systems".

2.17 OPTICAL FIBER CABLE

A. Optical Fiber Cable - For Indoor Use: Single Mode, optical fiber cable.

1. Optical fiber cables shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification and performance parameters of Fiber Optic Cable Category listed below so as to support and exceed the transmission performance Class E_A of EN50173-1.

   a. Category OS2.
2. Conductive cable shall be steel armored type.

B. Optical Fiber Cable - For Outdoor Use: Single Mode, optical fiber cable.

1. Optical fiber cables shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification and performance parameters of Fiber Optic Cable Category listed below so as to support and exceed the transmission performance Class E_A of EN50173-1.
   a. Category OS2.

2. Conductive cable shall be steel armored type.

C. Jacket:

1. Cable cordage jacket, fiber, unit, and group color shall be according to EN 50173-1.
2. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 1000 mm.

D. Number of Fiber Strands / Cores

1. The number of fiber strands shown on Drawings for various applications are indicative only. Contractor shall allow for strands in addition to those required for a specific system to ensure a minimum of 50% spare on all optical fiber cable links.

2.18 SINGLE-MODE OPTICAL FIBER CABLE – CATEGORY OS2

A. All backbone single-mode optical fiber cables shall be capable of Ethernet signal transmission at:

1. 100 Gb/s up to 40,000 meters in the 1550nm operating window.
2. 100 Gb/s up to 10,000 meters in the 1310nm operating window.

B. Maximum attenuation for a single-mode cable shall be no greater than 0.4dB/km and 0.4dB/km using 1310nm and 1550nm wavelengths respectively.

C. All optical fibers inside each individual cable shall be usable to the fullest capacity specified by the manufacturer and shall meet required specifications at all times.

D. All single-mode optical fiber cable jackets shall have: the industry standard
1. yellow colored jacket for ISP cables
2. black colored polyethylene jacket for OSP cables

E. All single-mode optical fiber cable jackets shall be spirally wrapped and encased within an interlocking armored metal made of aluminum or galvanized steel without interruption from end to end for protection and strength. The metallic armor shall also be wrapped in a black colored sheath to designate the type of optical fiber.

F. The optical fiber cables shall be rated per the installation environment as required by the local Authority Having Jurisdiction, National Fire Codes and MICE classification. Select an appropriate cable construction, including external jacket properties, when installing optical fiber cables in aerial, outdoor, underground and corrosive environments.

G. All single mode fiber optic cables shall meet or exceed EN 50173-1 compliant network cable-testing device certification by an independent laboratory, for verification of performance.

H. Accessory Products: Provide any accessory products related to the optical fiber backbone cabling required to provide a complete and functional infrastructure system.

2.19 OPTICAL FIBER CABLE HARDWARE

A. Optical Fiber Patch Bays (Panels)

1. Optical fiber patch bay housings shall be provided for cross-connecting or inter-connecting purposes between OSP, ISP, and/or distribution cables and the active network electronic switches.
2. All optical fiber termination panels shall be complete factory-provided assemblies that contain termination panels, factory-polished "pig tails", internal bend radius components and splice shelves that are provided in a housing which includes an accessible rear access hatch.
3. Optical fiber termination panels shall be suitable for installation in ECA TIA/ECA-310-E standard, 19-inch (482.6-mm) racks.
4. All connections between the horizontal and backbone optical fibers to the factory-provided "pig tails" within the termination shelves shall be made with a computer controlled, direct core, 3-axis electronic alignment, LED screen, push button controlled fusion splicing machine and protected by heat shrink fusion splice protection sleeves installed by an integrated heater within the same fusion splice machine.

5. All optical fiber patch panel trays and associated bulkhead inserts shall have factory numerical labeling included in the design and presentation to the user side of the panel.
6. The optical fiber patch panel bulkheads that house the terminating modules for the fiber backbone cabling and any station optical fiber cabling shall accept connectors on the end of each factory-terminated pigtail assembly.
7. The connectors shall conform to the requirements of the EN 50173 series for "Connecting Hardware Requirements" for performance parameters and shall have the same manufacturer, cable type, connector type and polish as noted above for the respective fiber optic cable (single-mode/multi-mode).

B. Patch Cords

1. Factory-made, dual-fiber cables in lengths that are appropriate for patching from network equipment ports to the optical fiber patch panels ports within the telecom spaces.

2. Patch cords shall conform to the requirements of the EN 50173 series for "Connecting Hardware Requirements" for standard performance parameters and shall have the same manufacturer, cable type, connector type and polish as noted above for the respective fiber optic cable (single-mode/multi-mode).

3. Jackets of patch cords shall have the industry standard yellow colored jacket for single-mode cables.

C. Cable Connecting Hardware:

1. Comply with EN 50173 series for "Connecting Hardware Requirements".
2. Quick-connect, simplex and duplex, Type LC connectors. Insertion loss not more than 0.75 dB at all wavelengths.

2.20 CONTROL AND SIGNAL CABLES

A. Multi-Core XLPE Insulated Control Cables: 0.6/1kV rating, multi-stranded circular copper conductors, with XLPE insulation of 7, 12, 19, 24, 30 or 37 cores. Cores shall be laid up together and filled with non-hygroscopic material, LS0H over-sheathed, to form compact and circular cable for use in switchgear, control gear and generally for control of power, motors, mechanical equipment and lighting systems. Armored cable shall have extruded XLPE bedding which may be an integral part of the filling, galvanized steel wire armoring, and over-sheath of LS0H type to IEC 60754 or BS EN 50267, IEC 61034 and IEC 60502-1, color black. Core identification shall be color-coded or shall have white printed numbers 1, 2, 3 etc. over black insulation at intervals not greater than 70 mm throughout the length of the core. Cross sectional area shall be certified by system vendor. The print shall be permanent and not easily removed. Cores shall be laid up in accordance with BS 5467. Cables shall be used for all installations inside the airport facilities and for installations in plenum areas outside airport facilities.

B. PE insulated control and signal cables, for use on data systems, shall be generally 300 V rating, polyethylene insulated, color-coded, tinned copper conductors (0.6-mm diameter), twisted together into pairs. Multi-pair core assembly shall be covered with binder tape, spirally wound 0.075-mm bare copper shielding tape and provided with drain wire and overall PVC sheath. Cables shall be used for installation outside the airport facilities except in air plenum.

C. Control and signal cables, enclosed in conduit and raceways with power cables, shall be insulated for same voltage grade.

D. All terminations shall be with tinned copper insulated lugs.

E. Conductors unless part of the individual equipment, shall be stranded and not less than 1.5 mm2 in cross section unless otherwise approved by the Engineer.

F. Conductors shall be of plain stranded annealed copper wires to IEC 60228 or BS 6360. Conductors less than 16 mm2 cross section shall be copper made up of 7 strands. Single strand conductor is not permitted.

G. Armor Bedding Multicore Cables: The armor bedding shall be of LS0H.

H. Armor: The armor shall consist of a single layer of galvanized steel wires complying with the requirements of BS EN 10257-1.

I. Jointing Accessories and Termination: Cables shall be terminated and jointed with accessories that have successfully been type tested. Straight through jointing of short cable lengths is not normally permitted but, in exceptional circumstances may be allowed subject to the Engineers' written approval. All cables entering or leaving terminal boxes shall be provided with separate terminations so that any cable out of a number of such cables can be removed or replaced without disturbing the remainder.

J. Modbus Cables: Use EIA-485 physical interface. Foamed High-density PE Insulated Data Cables: 0.3kV rating, 24 AWG stranded Copper Conductor, polyethylene insulation, twisted pairs, with aluminum Foil-Polyester Tape shielding plus a tinned copper braid shield with sunlight resistant PVC jacket. Modbus Cables shall be steel wire armoured with an outer jacket over armour. Operating temperature range to be between -10 to 50 deg C. Cables to be Flame tested according to UL and CSA standards. Only internal cable (interconnecting cable between panels in equipment rooms) shall be LS0H.

2.21 TWISTED PAIRS (BALANCED) ETHERNET CABLE

A. General Requirements

1. Balanced cables shall be rated per the installation environment as required by the local Authority Having Jurisdiction, National Fire Codes and MICE classification. Select an appropriate cable construction, including insulation, screen and external jacket properties, when installing Twisted Pair cables in harsh and corrosive environments.

2. Balanced cables that are exposed to moisture shall contain moisture-blocking materials to prevent moisture damage to cable performance.

3. Accessory Products: Provide any accessory products related to the Twisted Pair copper cabling required to provide a complete and functional infrastructure system.

B. Balanced cables shall be sufficiently free of surface imperfections and inclusions to meet the electrical, mechanical, and environmental requirements of this specification and performance parameters of Category 6A balanced cables so as to support and exceed the transmission performance Class E_A of EN 50173-1.

C. S/FTP (S-STP) Cable Description: 100-ohm, 23 AWG copper conductor, four-pair S-STP, Screened Shielded twisted pair Cable (braided screened overall, individually foil shielded twisted pairs cable), foam skin PE insulation and covered with a blue color, LSZH sheath and provided with a drain wire.

2.22 BALANCED CABLE HARDWARE

A. General Requirements for Cable Connecting Hardware: Comply with EN 50173 series for “Connecting Hardware Requirements”, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

B. Connecting Blocks: 110-style IDC for Category 6A. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

C. Cross-Connect: Modular array of connecting blocks arranged to terminate backbone cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables plus spares and blank positions adequate to suit specified expansion criteria.

D. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair conductor group of indicated cables, plus spares and blank positions adequate to suit specified expansion criteria.

E. Jacks and Jack Assemblies: Modular, color-coded, eight-position RJ45 modular receptacle units with integral IDC-type terminals.

F. Patch Cords: Factory-made, 4-pair copper conductor cables in lengths to suit application and routing requirements; LSZH jacket, terminated with 8-position RJ45 modular plug at each end.

1. Patch cords shall have color-coded boots for circuit identification.
2. Patch cables shall be performance and impedance matched with respective horizontal cables and provided by the same manufacturer of the horizontal cable.
3. Exceed EN 50173-1 Class E_A transmission performance.
4. Patch cords shall have bend-relief-compliant boots.

G. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position RJ45 modular Category 6A components, wired to T568A pin assignments,. Comply with EN 50173-2.

H. Workstation Outlets: Four-port-connector assemblies mounted in multi-gang faceplate.

1. Plastic Faceplate: High-impact plastic. Coordinate color with Section "Wiring Devices."
2. Metal Faceplate: Stainless steel, complying with requirements in Section "Wiring Devices."
3. For use with snap-in jacks accommodating any combination of balanced and optical fiber, work area cords.

a. Flush mounting jacks, positioning the cord at a 45-degree angle.

4. Legend: Factory labeled by silk-screening or engraving for stainless steel faceplates.
5. Legend: Machine printed, in the field, using adhesive-tape label.
6. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

2.23 UNINTERRUPTIBLE POWER SUPPLY (UPS)

A. All components of the SCADA system shall operate on dual redundant UPS units. The UPS shall be provided by the SCADA System Contractor to cater to the load of all system components as described above and as recommended by the SCADA system Supplier considering a maximum of 80% loading and 20% spare capacity for future expansion to the approval of the Engineer.

B. Provide Power Strips, connected to the UPS Units. Locate the power strips in the equipment racks and on the equipment backboards for powering all electronic systems in the Equipment Rooms. For Power Strips, refer to Section “Communications Equipment Room Fittings”.

C. UPS configuration - whether centralized or decentralized – shall be as per manufacturer's recommendation and Engineer's approval. Ensure that the allocated space and environmental conditions are adequate for the adopted configuration.

D. Remote field-mounted components shall be fed from the nearest UPS source.

E. Coordinate UPS power requirements, voltage, circuit size, and connection requirements with the Project Electrical design.

F. Ensure that the allocated space and environmental conditions are adequate for the adopted configuration.

G. Connect the UPS Units to Project Emergency Branch. UPS units shall allow for normal continuous operation for 30 minutes or until the Project emergency generators become online; whichever occurs first.

H. Provide shutdown connections from the UPS to servers for graceful power down in the event of a power failure.

I. Equip the UPS Units with SNMP Management Card connected to the SCADA Management VLAN.

J. Comply with Section "Static Uninterruptible Power Supply".

2.24 CONDUITS, TRUNKING AND FITTINGS

A. Comply with the following Specification Sections:

1. "Raceways and Boxes for Electrical Systems".
2. "Cable Trays for Electrical Systems".
3. "Underground Ducts and Raceways for Electrical Systems".

2.25 ACCESSORIES

A. Interfaces With Distribution Equipment Specified In Other Sections

1. Provide accessories, adapters, electronic interface units, and connections required for functional performance indicated.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General
1. All equipment shall be firmly secured in place unless requirements of portability dictate otherwise.
2. Equipment is to be laid out properly in communication rooms in a way to reserve relevant space for maintenance activities. This space shall also account for any future expansion of the system.
3. Installation shall be performed in accordance with the applicable standards, requirements, manufacturers' guidelines and any authorities having jurisdiction.
4. All boxes, equipment, etc. shall be plumb and square.

5. The Contractor shall take such precautions that are necessary to prevent and guard against electromagnetic interference. Refer to “Separation/Segregation of Services” paragraph in Section “Common Clauses for Structured Cabling” for separation from EMI sources.
6. After the proper layout of all equipment is accomplished, all components are to be labeled, and marked in accordance with Section “Identification for Communications Systems”.
7. During installation, consideration shall be given to operational efficiency as well as the overall aesthetic factors.
8. The Contractor shall supply and install all fittings and accessories, whether or not specified, required for proper, safe, and reliable operation of the system.
9. The Contractor shall ensure that safe ingress and egress from all work areas are maintained during movement and installation of equipment/materials.
10. Equipment Bases: Ensure that concrete bases and foundations provided for installation of equipment are constructed in accordance with approved shop and construction drawings and equipment manufacturers' drawings and that holes for fixing bolts and provisions for passage of cables etc. are provided as required.
11. Built-In Items: Ensure that equipment supports, fixings and the like, and sleeves for passage of feeders and cables which are to be built into concrete foundations, bases, cable trenches or building structure are provided as and when required and that they are properly installed.
12. Provide adequate grounding connections at all equipment to prevent the build-up of electromagnetic voltage potentials. Provide screening of panels, enclosures, devices, or components that emit interferences. All monitoring, control and communication cables shall be screened with one end earthed.

B. Examination
1. Examine the areas to receive the work and the conditions under which the work would be performed.
2. Examine all the communications rooms where equipment are to be deployed:
   a. Identify equipment location,
   b. Identify links on patch panels,
   c. Identify and check general power supply and grounding,
   d. Identify premises environmental characteristics (kW/m², air conditioning characteristics, etc.),
   e. Carry out heat dissipation calculations,
   f. Confirm feasibility for each communications room before starting to deploy.
3. Examine pathway elements intended for cable. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
4. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Rack Mounted Equipment
1. The Contractor shall install rack mounted equipment according to locations, elevations, and plan views developed by the Contractor and approved by the Employer.
2. Rack mounted equipment shall be bolted with at least 4 mounting screws for support.
3. Cable guide shall be installed between each 2U rack unit set of equipment to insure proper patch cable run and adequate air circulation.
4. All distribution hardware shall be securely mounted in a manner that allows access to the connections for testing and provides sufficient room for the doors or access panels to open and close without disturbing the cables.
5. Distribution and backbone cables shall enter from rear of optical patch panels.
6. Cables shall be maintained with D-Rings.
7. Each cable shall enter patch panel through adequate bushings and inserts where required by Manufacturer’s installation manuals/sheets.
8. Bond all metallic raceway, racks, cable runway, enclosure, and other metallic hardware to the dedicated bus bar.
9. Ensure that bonding breaks through paint to bare metallic surface of all painted metallic hardware.
10. All spare or unused space shall be obstructed through blank panels.

11. Arrange all inputs, outputs, interconnections, and test points so they are accessible at rear of rack for maintenance and testing, with each item removable from rack without disturbing other items or connections.

D. Wiring Methods
1. Comply with Sections
   a. “Raceways and Boxes for Electrical Systems”.
   b. “Cable Trays for Electrical Systems”.
   c. “Underground Ducts and Raceways for Electrical Systems”.

2. Comply with Sections:
   a. “Common Clauses for Structured Cabling”.
   b. “Identification for Communications Systems”.
   c. “Communications Equipment Room Fittings”.
3. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
4. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.
5. Install manufactured conduit sweeps and long-radius elbows whenever possible.
6. Terminate conductors; no cable shall contain un-terminated elements. Make terminations only at outlets and terminals.
7. Splices, Taps, and Terminations: Arrange on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Cables may not be spliced.
8. Secure and support cables at intervals not exceeding 760 mm (30 inches) and not more than 150 mm (6 inches) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
9. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
10. Visually inspect wire and cable for faulty insulation prior to installation.
11. Protect cable ends at all times with acceptable end caps except during actual termination.
12. After installation, and before termination, all wiring and cabling shall be checked and tested to ensure there are no grounds, opens, or shorts on any conductors or shields.
13. A V.O.M. shall be utilized to accomplish these tests and a reading of greater than 20 Mega ohms shall be required to successfully complete the test.
14. Install LAN cables using techniques, practices, and methods that are consistent with Category rating of components and fiber-optic rating of components, and that ensure Class E_A performance of completed and linked signal paths, end to end. Comply with Section "Communications Horizontal Cabling."
15. The Contractor shall install all cabling required to make all connections between the PLC/RTU, substation interfaces, power supplies and communications media.
16. The extra low voltage alarm, indication and control signals shall be carried in separate multi core cables. All the cores of each cable shall be terminated at each end in terminal blocks within cabinets/enclosures and these terminals shall be segregated as per the separation stated for the cables. The number of cores and terminals shall include at least 20% spare capacity of each type.

E. Cleaning
1. Inspect interior and exterior of installed devices. Remove paint-splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

F. Connections
1. Tighten connector, and terminal bolts according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in applicable Standards.

G. Weatherproof Equipment
1. For units that are mounted outdoors, in damp locations, or where exposed to weather, install consistent with requirements of weatherproof rating.

H. Impedance and Signal Levels
   1. Match input and output impedance and signal levels at signal interfaces. Provide matching networks where required.
   2. Patch wiring must be traceable: Keep a database of patch cords installation up-to-date including details of physical and logical connections.

I. Labeling and Marking
   1. Provide a typed schedule of all data ports according to each related room jack designation for all Technical Rooms in accordance with Section “Identification for Communications Systems”.
   2. Patch wiring must be traceable: Keep a database of patch cords installation up-to-date including details of physical and logical connections.
   3. Provide warning signs as specified in Section "Basic Electrical Materials and Methods".

J. Firestopping

   1. Refer to Section “Common Clauses for Structured Cabling”.
   2. Comply with requirements in Section "Penetration Firestopping".

K. Grounding
   1. Comply with Section “Grounding and Bonding for Electrical Systems”.
   2. Ground cable shields and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

L. Coordinate layout and installation of system components and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

3.2 FUSION SPLICING DEVICE

A. Check actual site conditions prior to start of any work. Ensure all preceding trade works associated with the telecommunications system are accurate and complete before proceeding with installation or use of products specified in this section.

B. Follow manufacturer’s instructions at all times when operating the optical fiber fusion splicing device. Pay particular attention to cleanliness and axis alignment.

C. Utilize the integrated tensile testing function of the splicing device after each splice to analyze the strength of the fiber joint. Comply with manufacturer’s recommendations for tensile testing load to be applied. Any splice failing the tensile test shall be re-spliced immediately.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. Perform tests and inspections.

   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

D. Testing and Inspections

1. All components shall be tested to ensure compliance with the specifications before they leave the Manufacturer's premises and shall be tested again on-site by the Contractor before the commencement of acceptance testing. The Contractor shall not ship components to the project site until they have been found to be fully compliant with the specifications and the Contractor shall not request the commencement of acceptance testing until such time as the Contractor has made a complete and thorough checkout of all equipment on site.

2. Any component furnished under this Contract shall be made available for inspections or tests, as deemed necessary by the Engineer. Use of any component by the Employer and Engineer shall not imply acceptance of the system or acceptability of any component. Availability and demonstration of the systems shall not be withheld and the use of components shall not imply the start of the Defects Liability Period.

3. Costs associated with the required inspections and testing shall be included in this scope of work. Additional charges will not be accepted.

4. The Contractor shall make available all equipment, calibrated instruments and ladders, as necessary to satisfactorily demonstrate the acceptability of the components and systems. Instrumentation to be used for the verification of monitored parameters shall be calibrated or supplied by an approved laboratory or manufacturer. Provide copies of the calibration data with the component test sheets.

5. Installation, engineering, software and system personnel shall be available on-site during the commissioning tests. These personnel shall be familiar with the installation and shall undertake all tests as requested by the Engineer in order to verify that the SCADA components individually and in total meet the specifications.

6. The Contractor shall confirm that the person(s) who will be conducting the commissioning tests on his behalf has been actively involved (on site) throughout the commissioning of the control system. Software shall be developed, tested and demonstrated over a time Span short enough to guarantee continuity of personnel.

E. Factory Acceptance Test (FAT)

1. Factory Acceptance Test shall include on the system basis the following test:
   a. System Hardware Tests.
   b. System Functional Tests.
   c. System Performance Tests.
   d. 100-hour Test (continuous run of the whole configuration).
   e. 30-minutes Major Disturbance test (Avalanche test).

2. The FAT shall be witnessed by the Employer and Engineer.

3. Successful FAT is a precondition for equipment delivery to the Site.

4. System Hardware Tests
   a. Performance testing shall be conducted of Servers and Workstations, including demonstration of CPU, Memory and Storage functions. All hardware enclosures shall be inspected.
   b. As a minimum, the following shall be inspected and verified:
      1) Cabinet enclosures
      2) Frame structure
      3) Paint work and finish
      4) Dimensions
      5) Console Panels physical layout
      6) Power supply mounting
      7) Power cable routing
      8) Data cable routing

9) Wiring runs properly installed
10) Fans and blowers are unobstructed
11) Power conditioning.

5. System Functional Tests
   a. System Functional tests shall be conducted to demonstrate the successful operation of every specified system function and shall include, but not be limited to, the following:
      1) Operating all devices both individually and collectively.
      2) Verification of proper data acquisition of all status and data points.
      3) Verification of proper uploading or downloading to the PLCs/RTUs.
      4) Demonstration of input and output accuracy.
      5) Testing of user interface functions.
      6) Verification of the correct sequence of operation at all the PLCs/RTUs.
      7) Simulation of communication error conditions and demonstration of error detection and handling.
      8) All specified display types, reports, and operator procedures shall be demonstrated and verified for accuracy.
      9) Create and process device failure conditions including PLC failure, Operator Workstation failure, peripheral failures, etc. Particular attention shall be given to creating failures in the middle of operator sequences and control actions such as:
         a) Communication failure after a command is issued but before the result is recorded in the database.
         b) Computer failure after a command is issued but before the result is recorded in the database.
         c) Failure of a major communications component.
         d) Operator Workstation failure in the middle of a control action.
         e) Incorrect operator entry in the middle of a multi-step action.
      10) Demonstration of the following functions:
         f) Redundant functions and components.
         g) Alarm processing functionality, including audible annunciation.
         h) IT interface functions.
         i) Historical capture, storage, and retrieval functions.
         j) Device control functions.
         k) Software support utilities.
         l) Data logging functions.
         m) System diagnostics, both on-line and off-line.
         n) Database management functionality.
         o) Correct operation of calculated quantities.
   b. Functional Testing of system software shall also include the following, as a minimum:
      1) Demonstration of restoration of system using backup media.
      2) Demonstration of the editing of system parameters including timers, etc.
      3) Demonstration of system modification capabilities including the addition and deletion or modification of points in a PLC, displays, report formats, control strategies, and the modification of the database and all database parameters.
      4) Demonstration of utility software facilities, including assembling, compiling, appending, and executing new programs.
      5) On-line program debug facilities, including downloading of a program from the central system to a remote PLC/RTU.

6. System Performance Tests:
   a. The FAT shall also include a live simulation of the control logic in association with the relevant HMI graphics.
      1) The following components shall be interconnected using the LAN equipment: Workstations, Printers, communication equipment and PLC/RTUs, with final configuration loaded, SCADA System Servers.

7. 100-hour Tests
    a. After the successful completion of the functional testing, a 100-hour continuous test of the system shall be initiated.
    b. The test shall be deemed successful if no system function is lost, no hardware or software failure occurs, and no module automatic failover occurs.
    c. The system shall be exercised with simulated inputs, events, and conditions in a manner similar to an operational environment.

8. A 30-minutes Major Disturbance Test
    a. In test, the environment described above shall exist.
    b. The system shall be dimensioned to handle a large-scale disturbance in the power system, including a total collapse in the controlled and monitored network.
    c. Such a case shall be tested by simulation in accordance with the outline description below:
        1) Most circuit-breakers are tripped.
        2) Most measured values go to zero.
        3) The automatic control functions work during the minutes that follow.
        4) Fault signals are received from most stations.
        5) The test shall run for 30 minutes.
    d. The requirements for this test are:
        1) That no information is lost.
        2) That the control system is usable throughout the entire test, i.e. it shall always be possible, for example, to call up displays and to make entries.
        3) That all events are recorded in event logs.
        4) Five minutes after the initial burst of indication changes, i.e. six minutes after the start of the major malfunction, the system shall meet the performance requirements of the normal load case.

F. Commissioning

1. Generally accepted industry standards, as well as manufacturer's written installation instructions, will be used as a basis for quality control and final acceptance of the works.

2. Site Acceptance Tests (SAT) represent a repetition of FAT under real conditions and with actual field data..

3. In-System Commissioning
    a. Equipment commissioning shall be done through demonstration of product capability and compliance with requirements after being wired and configured in the system.
    b. Test system and power supply redundancies by unplugging redundant links.
    c. Check recovery times.

4. The Contractor shall be required to perform a range of Site Acceptance Tests on site for each individual sub-system to demonstrate that all items have been correctly installed and adjusted on a location by location basis and that the sub-system operates in every respect in accordance with the Specifications.
    a. During this commissioning phase, the equipment is powered and the automation and networking are gradually integrated layer by layer.
    b. Any defects, which may become apparent during the course of these tests, shall be immediately rectified by the Contractor at his expense.
    c. The Site Acceptance Test Specifications shall be prepared by the Contractor and submitted for Approval by the Engineer and Employer.
    d. All Site Acceptance Tests shall be carried out in the presence of the Employer who shall sign off the testing documentation on satisfactory completion of the tests.
    e. The Site Acceptance Test Specifications shall at every level, be subjected to configuration management and change control by the Contractor.

f. If modification or reprogramming is required as a result of the tests, all affected parts of the Site Acceptance Tests, as determined by the Employer, shall be re-tested.
g. The results of the Site Acceptance Tests (SAT), version of software and hardware tested, together with any re-testing as a result of failure, shall be recorded and signed by the authorized personnel of the Contractor and the Employer.

5. Those tests shall be carried out over two phases.
   a. Preliminary Testing:
      1) Mechanical:
      - Mechanical tests,
      - Calibration of the components.
      2) Automatism / Electrical:
      - Powering Tests with electricity,
      - Control of Input/Output,
      - Control of the safety measure either personal or material,
      - Test of local mode operation.
      3) Network / Software Tests:
      - Test of the Network,
      - Test of the Supervision Workstation user interface,
      - Test of the portable Terminal user interface.
   b. System Testing
      1) The tests performed during this phase are performed with and without loading conditions: Testing the crippled mode (Safe shut down consecutive to loss of energy, etc.).

G. General Inspection

1. Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.
2. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements.
3. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.
4. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.
5. Optical Fiber Cable Tests:
   a. Conduct the tests in accordance with EN 50346 and ISO/IEC 14763-3 for compliance with the relevant limits specified in EN 50173-1 or the applicable application-specific standard.
   b. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
   c. Test for:
      1) Link End-to-End Attenuation.
      2) Continuity and maintenance of polarity.
      3) Length.
      4) Propagation delay.
      5) Optical attenuation of link, 2 x wavelengths, 2 x direction.
      6) Where results exceed the power loss budget, the link shall be investigated with an OTDR to determine the location of the faulty component.

H. The system will be considered defective if it does not pass tests and inspections.

I. Prepare test and inspection reports.

J. Experimental Period: As described under “WARRANTY” Article. Demonstrate successful operation to confirm, to the satisfaction of the Engineer, that the system is free of remarks and is ready for taking-over.

3.4 OCCUPANCY ADJUSTMENTS

A. When requested within 12 months of date of Taking Over of, provide on-site assistance in adjusting and calibrating components and assisting Employer's personnel in making program changes and in adjusting sensors and controls to suit actual conditions. Provide up to three visits to Project site during other-than-normal occupancy hours for this purpose. Visits for this purpose shall be in addition to any required by warranty.

3.5 DEMONSTRATION AND TRAINING

A. Engage a factory-authorized service representative to train Employer's maintenance personnel to configure, program, adjust, operate, and maintain SCADA system equipment. Refer to Division 01 Section "Demonstration and Training Closeout Procedures."

B. In order to provide a reliable training, Employer’s maintenance personnel who are involved in the training program of this system, could be involved in the follow up of system installation as well. The Contractor shall provide an installation agenda to the Employer and confirm with him any coordination with assigned trainees.

C. Training Program
   1. Scope: Training shall be in sufficient scope to ensure that all trainees who complete the program will be certified as capable to operate and/or maintain the equipment, systems, and facilities provided and installed under this Contract, and to ensure a smooth transition between construction and operations activities.
   2. Language: Training shall be conducted in English.
   3. Training Aids shall include:
      a. Approved Operation and Maintenance (O & M) manual(s) prepared by the Contractor as part of this Contract,
      b. Training manuals, including course outline, basic text of instructions modules, and trainee workbook,
      c. Films, slides, video tape(s),
      d. Charts, models, hand-outs, catalogues,
      e. Samples and other visual,
      f. Written aids to complement instruction.
      g. In addition, spare parts and other special hardware shall be provided to support “hands-on” familiarization with the equipment or systems.
   4. Training Manuals
      a. Training manuals shall be provided for each training course covering both the classroom and on-the-job phases.
      b. The organization of the manuals shall follow the same sequence as the course’s scheduled presentation of material, providing such additional background and supplementary information, as a trainee may need to understand the O & M manuals.
      c. There shall be as many Training Manual types as Trainees categories.
   5. Training shall be performed in accordance with an approved training program. All training aids shall be available and approved prior to start of training.
   6. Course Contents
      a. Training course can be broken down into modules either classroom lecture or ‘On-the-job’ training.
      b. In case of lecture, it is the Employer responsibility to provide the classroom for the duration of the course.
      c. No lecture module should exceed 2-hours interval.
      d. “On-the-job” training can be scheduled for an entire 8 hour shift.

e. Handouts must support each module; the collation of the Handouts forms the Training Manual.
f. Laboratory equipment, spare parts, and mock-up models may be used for theoretical orientation.
g. However, practical "hands-on" familiarization shall be provided on equipment that is either installed and operable or ready to be installed and capable of being operated. **SCADA system** spares of special hardware items may be used to support "hands-on" familiarization as long as said spares are returned to inventory in satisfactory condition in accordance with approved procedures.
h. The Contractor shall provide a training environment of its **SCADA system**, which can be similar to the "test environment". All future operations shall be reproduced in this training environment with no consequences on the test or on the operational environment.
i. Training schedules: the Contractor shall indicate the duration of all sessions, the number of trainees and how they shall fit into the overall project planning.
j. Training facilities: the Contractor shall provide facilities for the training of the maintenance staff, trainers and end-users including equipment, software and documentation.

D. The Contractor shall provide training for **SCADA** operational, maintenance and administration staff:
1. Operators shall be provided with a thorough training in all aspects of system/sub-system operation under both normal and abnormal conditions. This training shall include, but not be limited to:
a. Orientation to provide overview of system/sub-system purpose, configuration, and operations,
b. Terminology,
c. Operations theory and interface,
d. Equipment appearance, functions, concepts and operations,
e. Operating mode, practices, and procedures under normal and emergency conditions,
f. Safety precautions,
g. On-the-job operating experience covering all system/sub-system operating functions, activities, and tasks including those associated with degraded operating modes, failure recognition, and recovery processes,
h. Familiarity with content and use of O & M manuals and related reference publications.
2. Maintenance Training
a. Maintenance training shall cover all on-site routine, preventive, and remedial maintenance of the system/sub-system.
b. This training shall include, but not be limited to:
1) Orientation to provide overview of system/sub-system purpose, configuration, and operations,
2) Terminology,
3) Operations theory and interfaces,
4) Equipment appearance, layout, functions, concepts and operations,
5) Operating modes, practice, and procedures under normal and emergency conditions,
6) Safety precautions,
7) Use of tools and test equipment,
8) Use of system utilities, diagnostic software and various software tools associated with the system maintenance,
9) Preventive maintenance,
10) Troubleshooting, diagnostics, and testing,
11) Backup and restoration of software/configuration,
12) Assembly and disassembly,
13) Repair and parts replacement,
14) Parts ordering practices and storage,
15) Failure and recovery procedures,
16) System/sub-system cabling,

17) Familiarization with and use of O & M manuals and other reference materials.

3. Administrator Training
   a. Administrator course shall be provided so the system administration staff will be able to:
      1) Identify and remedy software faults,
      2) Upgrade and implement data and software changes,
      3) Production of revised or new displays.
   b. This training shall include, but not be limited to:
      1) Orientation to provide overview of system/sub-system purpose, configuration, and operations,
      2) Terminology,
      3) Operations theory and interfaces,
      4) Software design and organization,
      5) Database structure, generation, and modification,
      6) Assembly, compilation, linking, editing, debugging, distributing, testing and integration of program modules,
      7) Interface software design,
      8) Configuration management and control of software,
      9) Backup and restoration of software,
      10) Use of system utilities, diagnostic software and various software tools associated with the design, development, and maintenance of the System,
      11) Familiarization with and use of O & M manuals and other reference materials.

END OF SECTION 260914

Z10 PURPOSE MADE JOINERY

To be read with Preliminaries/ General Conditions.

110 FABRICATION

- Standard: To BS 1186-2.
- Sections: Accurate in profile and length, and free from twist and bowing. Formed out of solid unless shown otherwise.
  - Machined surfaces: Smooth and free from tearing, wooliness, chip bruising and other machining defects.
- Joints: Tight and close fitting.
- Assembled components: Rigid. Free from distortion.
- Screws: Provide pilot holes.
  - Screws of 8 gauge (4 mm diameter) or more and screws into hardwood: Provide clearance holes.
  - Countersink screws: Heads sunk at least 2 mm below surfaces visible in completed work.
- Adhesives: Compatible with wood preservatives applied and end uses of timber.

120 CROSS SECTION DIMENSIONS OF TIMBER

- General: Dimensions on drawings are finished sizes.
- Maximum permitted deviations from finished sizes:
  - Softwood sections: To BS EN 1313-1:-
    Clause 6 for sawn sections.
  - Hardwood sections: To BS EN 1313-2:-
    Clause 6 for sawn sections.
    Clause NA.3 for further processed sections.

130 PRESERVATIVE TREATED WOOD

- Cutting and machining: Completed as far as possible before treatment.
- Extensively processed timber: Retreat timber sawn lengthways, thicknessed, planed, ploughed, etc.
- Surfaces exposed by minor cutting and/ or drilling: Treat as recommended by main treatment solution manufacturer.

140 MOISTURE CONTENT

- Wood and wood based products: Maintained within range specified for the component during manufacture and storage.

210 LAMINATED PLASTICS VENEERED BOARDS/ PANELS

- Fabrication: To British Laminated Plastics Fabricators Association Ltd (BLF) fabricating standards.
- Balancing veneer: From decorative veneer manufacturer and of similar composition. Applied to reverse side of core material.
- Finished components: Free from defects, including bow, twist, scratches, chipping, cracks, pimpling, indentations, glue marks, staining and variations in colour and pattern.
- Joints visible in completed work: Tight butted, true and flush.

250 FINISHING

- Surfaces: Smooth, even and suitable to receive finishes.
  - Arrises: Eased unless shown otherwise on drawings.
- End grain in external components: Sealed with primer or sealer as section M60 and allowed to dry before assembly.

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Z11 PURPOSE MADE METALWORK

To be read with Preliminaries/ General Conditions.

310 MATERIALS GENERALLY

- Grades of metals, section dimensions and properties: To appropriate British Standards. When not specified, select grades and sections appropriate for the purpose.
- Prefinished metal: May be used if methods of fabrication do not damage or alter appearance of finish, and finish is adequately protected.
- Fasteners: To appropriate British Standards and, unless specified otherwise, of same metal as component being fastened, with matching coating or finish.

320 STEEL LONG AND FLAT PRODUCTS

- Hot rolled structural steels (excluding structural hollow sections and tubes): To BS EN 10025-1.
- Fine grain steels, including special steels: To BS EN 10025-3 and -4.
- Steels with improved atmospheric corrosion resistance: To BS EN 10025-5.

330 STEEL PLATE, SHEET AND STRIP

- Plates and wide flats, high yield strength steel: To BS EN 10025-6.

340 HOT ROLLED STEEL PLATE, SHEET AND STRIP

- Flat products, high yield strength for cold forming: To BS EN 10149-1, -2 and -3.
- Carbon steel sheet and strip for cold forming: To BS EN 10111.
- Narrow strip, formable steel and steel for general engineering purposes: To BS 1449-1.8 and BS 1449-1.14.

350 COLD ROLLED STEEL PLATE, SHEET AND STRIP

- Steel sections: To BS EN 10162.
- Flat products, high yield strength micro-alloyed steels for cold forming: To BS EN 10268.
- Carbon steel flat products for cold forming: To BS EN 10130 and BS EN 10131.
- Uncoated carbon steel narrow strip for cold forming: To BS EN 10139 and BS EN 10140.
- Narrow strip steel for general engineering purposes: To BS EN 10132-1, -2, and -3.
- Carbon steel flat products for vitreous enamelling: To BS EN 10209.

360 COATED STEEL FLAT PRODUCTS

- Hot dip zinc coated carbon steel sheet and strip for cold forming: To BS EN 10346 and BS EN 10143.
- Hot dip zinc coated structural steel sheet and strip: To BS EN 10143 and BS EN 10346.
- Organic coated flat products: To BS EN 10169.

370 STEEL STRUCTURAL HOLLOW SECTIONS (SHS)

- Non alloy and fine grain steels, hot finished: To BS EN 10210-1 and -2.
- Non-alloy and fine grain steels, cold formed welded: To BS EN 10219-2.
- Weather resistant steels, hot finished: To BS 7668.

380 OTHER STEEL SECTIONS

- Equal flange tees: To BS EN 10055.
- Equal and unequal angles: To BS EN 10056-1 and -2.
- Wire, carbon steel for general engineering purposes: To BS 1052.
- Wire and wire products, general: To BS EN 10218-2.
- Tubes:

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- Seamless circular: To BS EN 10297-1.
- Seamless cold drawn: To BS EN 10305-1.
- Welded and cold sized square and rectangular: To BS EN 10305-5.
- Welded circular: To BS EN 10296-1.
- Welded cold drawn: To BS EN 10305-2.
- Welded cold sized: To BS EN 10305-3.

390 WARRANTY

General Warranty: The warranty specified in this Article shall not deprive the Employer of other rights the Employer may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties provided in accordance with the express requirements of the Contract Documents.

Full System Warranty: Provide full system warranty in which Manufacturer, contractor and Installer are jointly and severally responsible and agree to repair or replace, without limitations, any high-performance coating system that fails within the specified warranty period.

Failure includes, but shall not be limited to the following:

Peeling or blistering of paint.
Cracking of paint film.
Crazing of paint film.
Change in color of finish topcoat.
Staining.
Patchiness of sheen or color.

Warranty Period for Protective paint systems over abrasive blasted steel substrates: 20 years from the date of Substantial Completion.
Warranty Period for Hot Dip Galvanized items:15 years from the date of Substantial Completion.
Warranty Period for Duplex (HDG+ paint system) coated steel substrates: 20 years from the date of Substantial Completion.

411 METAL PRIMERS

- As recommended by coating system manufacturer based on substrate type, site corrosion category, and warranty duration. Minimum number of coats and dry film thicknesses to comply with ISO 12944-5 minimum requirements.

  - Zinc-Rich Inorganic Primer: Corrosion-resistant, inorganic-based, zinc-rich primer; formulated for use on prepared steel that will be exposed to severe industrial or severe marine environments.
  - Epoxy Zinc-Rich Primer: Solvent-based, multi-component, epoxy-type anti-corrosive primer; formulated for use on cleaned ferrous metal surfaces that will be exposed to moderate industrial or marine environments.
  - Water-Based, Rust-Inhibitive Primer: Corrosion-resistant, water-based-emulsion primer; formulated for resistance to flash rusting when applied to cleaned, ferrous metals that will be exposed to mildly corrosive environments.
  - Epoxy, Anti-Corrosive Primer: Two-component, epoxy, anti-corrosive primer; formulated for use on ferrous, galvanized metal surfaces, and the like.

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415 HOT-DIPPED GALVANIZED STEEL FINISHES AND CARBON STEEL FINISHES

- Protective colored paint system: Paint system obtained from single manufacturer consisting of colored exterior coating over an anti-corrosive zinc rich pigmented primer and a barrier coat(s) where needed and as per manufacturer's recommended system. Color of coating system applied is to be selected by the Engineer from manufacturer's full range of colors and gloss. Polyurethane based top coats to be used for all exterior UV exposed elements.

  Substrate: Minimum G90 hot dip galvanized steel, or abrasive blasted carbon steel.
- The contractor shall provide corrosion protection to the steelwork, which has the following durability and maintenance characteristic:
- Fully compliant to the pertinent provisions of ISO 12944. Time to first maintenance shall be 25 years as a minimum for all categories of systems conforming to Very High (VH) durability to ISO 12944-5 for corrosivity category C5. All primers and paints shall be standard proprietary products manufactured by an approved manufacturer. The application of paint shall be in complete conformity to Manufacturer's recommendations and shall be guaranteed for 20 years (except for Duplex coating systems) as minimum for all categories of systems defined in accordance with ISO 12944-8. Minimum number of coats and dry film thicknesses to comply with ISO 12944-5 minimum requirements.

A. Hot Dip Galvanization Finish: Hot-dip galvanized items shall comply with ISO 1461 Table 3 and 4 or ASTM A123/123M, or ISO 14713-1 table 2 achieving the design life to first maintenance of 25 plus years conforming to Very High (VH) durability for corrosivity category C5 as outlined by ISO 14713-1. The application of hot dip galvanization shall be in complete conformity to applicable standards and shall be guaranteed for 15 years from date of substantial completion. All Hot dip galvanized items located outside the air and vapor control layer shall have a minimum coating designation of Z600 or a coating thickness not less than 85 microns.

B. Box members and hollow sections:

1. All structural box members and hollow components that are not hot dip galvanized, shall be impervious to air and moisture. For this purpose, all edges shall be sealed by means of continuous welds and any opening shall be provided with sealing covers. During the assembly of such components, care shall be taken to ensure that no water is trapped.
2. No penetrations shall be permitted during or after completion of works.

C. Steel protection systems shall undergo regular inspections by manufacturer/applicator at intervals as required by system manufacturer but not to exceed every 18 months.

FABRICATION

515 FABRICATION GENERALLY

- Contact between dissimilar metals in components: Avoid.
- Finished components: Rigid and free from distortion, cracks, burrs and sharp arrises.
  - Moving parts: Free moving without binding.
- Corner junctions of identical sections: Mitre.

520 COLD FORMED WORK

- Profiles: Accurate, with straight arrises.

525 ADHESIVE BONDING

- Preparation of surfaces of metals to receive adhesives:
  - Degrease.
  - Abrade mechanically or chemically etch.

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  - Prime: To suit adhesive.
- Adhesive bond: Form under pressure.

527 WELDING GENERALLY

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- Welding procedures:
  - Method and standard: Metal arc welding to BS EN 1011-1 and -2 for steel and TIG welding to BS EN 1011-3 for stainless steel TIG or MIG welding to BS EN 1011-4 for aluminium alloys.
  - Welding Procedure Specification (WPS): Not required.
- Preparation:
  - Joint preparation: Clean thoroughly.
  - Surfaces of materials that will be self-finished and visible in the completed work: protect from weld splatter.
- Jointing:
  - Joints: Fully bond parent and filler metal throughout with no inclusions, holes, porosity or cracks.
  - Dissimilar metals: Welding not permitted.
  - Strength requirements: Welds to achieve design loads.
  - Heat straightening: Not permitted.
  - Complex assemblies: Agree priority for welding members to minimize distortion caused by subsequent welds.
  - Tack welds: Use only for temporary attachment.
  - Jigs: Provide to support and restrain members during welding.
  - Filler plates: Obtain approval and submit proposals.
  - Lap joints: Minimum 5 x metal thickness or 25 mm, whichever is greater.
  - Weld terminations: Clean and sound.

FINISHING

710 FINISHING WELDED AND BRAZED JOINTS VISIBLE IN COMPLETE WORK

- Standard: To BS EN ISO 8501-3.
  - Preparation grade: P1.
- Butt joints: Smooth, and flush with adjacent surfaces.
- Fillet joints: Neat.
- Grinding: Grind smooth where indicated on drawings.

745 PREPARATION FOR APPLICATION OF COATINGS

- General: Complete fabrication, and drill fixing holes before applying coatings.
- Paint, grease, flux, rust, burrs and sharp arrises: Remove.

790 VITREOUS ENAMELLING

- Standard: To BS EN ISO 28722.
- Substrate metal: Steel to BS EN 10209.

COMPLETION

910 DOCUMENTATION

- Submit:
  - Manufacturer's maintenance instructions.
  - Guarantees, warranties, test certificates, record schedules and log books.

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920 COMPLETION

- Protection: Remove.
- Cleaning and maintenance: Carry out in accordance with procedures detailed in fabricators' guarantees.

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Z12 PRESERVATIVE/ FIRE RETARDANT TREATMENT

To be read with Preliminaries/ General Conditions.

110 TREATMENT APPLICATION

- Timing: After cutting and machining timber, and before assembling components.
- Processor: Licensed by manufacturer of specified treatment solution.
  - Operatives: Must have completed the PCA training scheme or WPA certified or equivalent.
- Certification: For each batch of timber provide a certificate of assurance that treatment has been carried out as specified.

120 COMMODITY SPECIFICATIONS

- Standard: Current edition of the Wood Protection Association (WPA) publication 'Industrial wood preservation specification and practice'.

130 PRESERVATIVE TREATMENT SOLUTION STRENGTHS/ TREATMENT CYCLES

- General: Select to achieve specified service life and to suit treatability of specified wood species.

165 WATER-BASED MICROEMULSION PRESERVATIVE TREATMENT

- Solution:
  - Manufacturer: Submit proposals.
    Product reference: Submit proposals.
  - Application: Double vacuum + low pressure impregnation.
- Moisture content of wood:
  - At time of treatment: As specified for the timber/ component at time of fixing.
  - After treatment: Timber to be surface dry before use.

210 FIRE RETARDANT TREATMENT

- Solution type: Humidity resistant.
  - Manufacturer: Submit proposals.
    Product reference: Submit proposals.
  - Application: Vacuum + pressure impregnation.
- Moisture content of wood:
  - At time of treatment: As specified for the timber/ component at time of fixing.
  - After treatment: Timber to be redried slowly at temperatures not exceeding 65°C to minimize distortion and degradation.

240 PRESERVATIVE TREATMENT APPLICATION

- The preservative treatment is to be applied by pressure impregnation or the double vacuum process. Dipping, deluging, spraying, brushing or other methods which only provide shallow protection are not permitted.
- The treatment to be carried out under factory conditions at the source of supply of the timber and the Subcontractor is to provide a Certificate of Impregnation when required by the Contractor.
- Treatment is to be carried out after all cutting and shaping has been completed.
  - If subsequent cutting of the timber is unavoidable all freshly exposed surfaces are to receive a liberal application of the preservative recommended in the relevant treatment specification.

250 STANDARD PRESSURE TREATED PRESERVATIVE

- Wood members and plywood exposed to weather or in contact with plaster, masonry or concrete, including wood framing of openings in exterior walls of concrete or masonry, roofed structures; wood

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sills, sole plates, furring and wood members used in connection with roofing and flashing materials to be treated in accordance with BS 1282, BS 5268, BS 6566, and/or BS 5707.

260 TERMITE AND OTHER INSECT TREAT MENTFUNGAL TREATMENT

- All hardwood and softwood for permanent incorporation in the Works is to be treated with preservative to provide protection against damage from insect larvae, termites and fungal decay to BS 6566, Part 7. Organic solvent type preservatives are to contain a water repellent.
  - Certificates are to be provided confirming all necessary treatments required have been completed.
- For treatment to timber laminated beams and columns refer to Section M60- PAINTING.

610 MAKING GOOD TO PRESERVATIVE TREATMENT ON-SITE

- Preservative solution: Compatible with off-site treatment.
- Application: In accordance with preservative manufacturer's recommendations.

620 MAKING GOOD TO FIRE RETARDANT TREATMENT ON-SITE

- Fire retardant: Compatible with off-site treatment.
- Application: In accordance with fire retardant manufacturer's recommendations.

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Z20 FIXINGS AND ADHESIVES

To be read with Preliminaries/ General Conditions.

PRODUCTS

310 FASTENERS GENERALLY

- Materials: To have:
  - Bimetallic corrosion resistance appropriate to items being fixed.
  - Atmospheric corrosion resistance appropriate to fixing location.
- Appearance: Submit samples on request.

320 PACKINGS

- Materials: Non-compressible, corrosion proof.
- Area of packings: Sufficient to transfer loads.

330 NAILED TIMBER FASTENERS

- Nails:
  - Steel: To BS 1202-1 or BS EN 10230-1.
  - Copper: To BS EN 1202-2.
  - Aluminium: To BS 1202-3.

340 MASONRY FIXINGS

- Light duty: Plugs and screws.
- Heavy duty: Expansion anchors or chemical anchors.

350 PLUGS

- Type: Proprietary types to suit substrate, loads to be supported and conditions expected in use.

360 ANCHORS

- Types:
  - Expansion: For use in substrate strong enough to resist forces generated by expansion of anchor.
  - Adhesive or chemical:
    For use in substrate where expansion of anchor would fracture substrate.
    For use in irregular substrate where expansion anchors cannot transfer load on anchor.
  - Cavity: For use where the anchor is retained by toggles of the plug locking onto the inside face of the cavity.

370 WOOD SCREWS

- Type:
  Wood screws (traditional pattern).
  Standard: To BS 1210.
  Wood screws.
  Pattern: Parallel, fully threaded shank or twin thread types.
- Washers and screw cups: Where required are to be of same material as screw.

380 MISCELLANEOUS SCREWS

- Type: To suit the fixing requirement of the components and substrate.
  - Pattern: Self-tapping, metallic drive screws, or power driven screws.
- Washers and screw cups: Where required to be of same material as screw.

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390 ADHESIVES GENERALLY

- Standards:
  - Hot-setting phenolic and aminoplastic: To BS 1203.
  - Thermosetting wood adhesives: To BS EN 12765.
  - Thermoplastic adhesives: To BS EN 204.

410 POWDER ACTUATED FIXING SYSTEMS

- Types of fastener, accessories and consumables: As recommended by tool manufacturer.

EXECUTION

610 FIXING GENERALLY

- Integrity of supported components: Select types, sizes, quantities and spacings of fixings, fasteners and packings to retain supported components without distortion or loss of support.
- Components, substrates, fixings and fasteners of dissimilar metals: Isolate with washers/ sleeves to avoid bimetallic corrosion.
- Appearance: Fixings to be in straight lines at regular centres.

620 FIXING THROUGH FINISHES

- Penetration of fasteners and plugs into substrate: To achieve a secure fixing.

630 FIXING PACKINGS

- Function: To take up tolerances and prevent distortion of materials and components.
- Limits: Do not use packings beyond thicknesses recommended by fixings and fasteners manufacturer.
- Locations: Not within zones to be filled with sealant.

640 FIXING CRAMPS

- Cramp positions: Maximum 150 mm from each end of frame sections and at 600 mm maximum centres.
- Fasteners: Fix cramps to frames with screws of same material as cramps.
- Fixings in masonry work: Fully bed in mortar.

650 NAILED TIMBER FIXING

- Penetration: Drive fully in without splitting or crushing timber.
- Surfaces visible in completed work: Punch nail heads below wrot surfaces.
- Nailed timber joints: Two nails per joint (minimum), opposed skew driven.

660 SCREW FIXING

- Finished level of countersunk screw heads:
  - Exposed: Flush with timber surface.
  - Concealed (holes filled or stopped): Sink minimum 2 mm below surface.

670 PELLETED COUNTERSUNK SCREW FIXING

- Finished level of countersunk screw heads: Minimum 6 mm below timber surface.
- Pellets: Cut from matching timber, match grain and glue in to full depth of hole.
- Finished level of pellets: Flush with surface.

680 PLUGGED COUNTERSUNK SCREW FIXING

- Finished level of countersunk screw heads: Minimum 6 mm below timber surface.
- Plugs: Glue in to full depth of hole.
- Finished level of plugs: Projecting above surface.

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690 USING POWDER ACTUATED FIXING SYSTEMS

- Powder actuated fixing tools: To BS 4078-2 and Kitemark certified.
- Operatives: Trained and certified as competent by tool manufacturer.

700 APPLYING ADHESIVES

- Surfaces: Clean. Adjust regularity and texture to suit bonding and gap filling characteristics of adhesive.
- Support and clamping during setting: Provide as necessary. Do not mark surfaces of or distort components being fixed.
- Finished adhesive joints: Fully bonded. Free of surplus adhesive.

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Z21 MORTARS

To be read with Preliminaries/ General Conditions.

CEMENT GAUGED MORTARS

110 CEMENT GAUGED MORTAR MIXES

- Specification: Proportions and additional requirements for mortar materials are specified elsewhere.

120 SAND FOR SITE MADE CEMENT GAUGED MASONRY MORTARS

- Standard: To BS EN 13139.
- Grading: 0/2 (FP or MP).
  - Fines content where the proportion of sand in a mortar mix is specified as a range (e.g. 1:1: 5-6):
    Lower proportion of sand: Use category 3 fines.
    Higher proportion of sand: Use category 2 fines.
- Sand for facework mortar: Maintain consistent colour and texture. Obtain from one source.

161 CEMENTS FOR MORTARS

- Cement: To BS EN 197-1 and CE marked.
  - Types: Portland cement, CEM I.
    Portland limestone cement, CEM ll/A-L or CEM ll/A-LL.
    Portland slag cement, CEM II/B-S.
    Portland fly ash cement, CEM II/B-V.
  - Strength class: 32.5, 42.5 or 52.5.
- White cement: To BS EN 197-1 and CE marked.
  - Type: Portland cement, CEM I.
  - Strength class: 52.5.
- Sulfate resisting Portland cement:
  - Type: To BS EN 197-1 Sulfate resisting Portland cement, CEM I/SR and CE marked.
    To BS EN 197-1 fly ash cement, CEM ll/B-V and CE marked.
  - Strength class: 32.5, 42.5 or 52.5.
- Masonry cement: To BS EN 413-1 and CE marked.
  - Class: MC 12.5.
- Do not use lime unless otherwise approved by Engineer for particular work and application.

180 ADMIXTURES FOR SITE MADE CEMENT GAUGED MORTARS

- Air entraining (plasticizing) admixtures: To BS EN 934-3 and compatible with other mortar constituents.
- Other admixtures: Submit proposals.
- Prohibited admixtures: Calcium chloride, ethylene glycol and any admixture containing calcium chloride.

190 RETARDED READY TO USE CEMENT GAUGED MORTAR

- Standard: To BS EN 998-2.
- Lime for cement: lime: sand mortars: Nonhydraulic to BS EN 459-1.
  - Type: CL 90S.
- Pigments for coloured mortars: To BS EN 12878.
- Time and temperature limitations: Use within limits prescribed by mortar manufacturer.
  - Retempering: Restore workability with water only within prescribed time limits.

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200 STORAGE OF CEMENT GAUGED MORTAR MATERIALS

- Sands and aggregates: Keep different types/ grades in separate stockpiles on hard, clean, free-draining bases.
- Factory made ready-mixed lime:sand/ ready to use retarded mortars: Keep in covered containers to prevent drying out or wetting.
- Bagged cement/ hydrated lime: Store off the ground in dry conditions.

210 MAKING CEMENT GAUGED MORTARS

- Batching: By volume. Use clean and accurate gauge boxes or buckets.
  - Mix proportions: Based on dry sand. Allow for bulking of damp sand.
- Mixing: Mix materials thoroughly to uniform consistency, free from lumps.
  - Mortars containing air entraining admixtures: Mix mechanically. Do not overmix.
- Working time (maximum): Two hours at normal temperatures.
- Contamination: Prevent intermixing with other materials.

LIME: SAND MORTARS DO NOT USE LIME.

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Z22 SEALANTS

To be read with Preliminaries/General Conditions.

PRODUCTS

310 JOINTS GENERALLY

- Primer, backing strip, bond breaker: Types recommended by sealant manufacturer.

EXECUTION

610 SUITABILITY OF JOINTS

- Presealing checks:
  - Joint dimensions: Within limits specified for the sealant.
  - Substrate quality: Surfaces regular, undamaged and stable.
- Joints not fit to receive sealant: Submit proposals for rectification.

620 PREPARING JOINTS

- Surfaces to which sealant must adhere:
  - Remove temporary coatings, tapes, loosely adhering material, dust, oil, grease, surface water and contaminants that may affect bond.
  - Clean using materials and methods recommended by sealant manufacturer.
- Vulnerable surfaces adjacent to joints: Mask to prevent staining or smearing with primer or sealant.
- Backing strip and/ or bond breaker installation: Insert into joint to correct depth, without stretching or twisting, leaving no gaps.
- Protection: Keep joints clean and protect from damage until sealant is applied.

630 APPLYING SEALANTS

- Substrate: Dry (unless recommended otherwise) and unaffected by frost, ice or snow.
- Environmental conditions: Do not dry or raise temperature of joints by heating.
- Sealant application: Fill joints completely and neatly, ensuring firm adhesion to substrates.
- Sealant profiles:
  - Butt and lap joints: Slightly concave.
  - Fillet joints: Flat or slightly convex.
- Protection: Protect finished joints from contamination or damage until sealant has cured.

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Z31 POWDER COATINGS

To be read with Preliminaries/ General Conditions.

120 POWDER COATING MATERIALS

- Manufacturer: Obtain from one only of the following: Submit proposals for Engineer's approval.
- Selected manufacturer: Submit details before commencement of powder coating including:
  - Name and contact details.
  - Details of accreditation schemes.
  - Technical data of product including current Agrément certificates.

210 WORKING PROCEDURES

- Comply with the follow following standards.
  - Aluminium components: To BS 6496 or BS EN 12206-1.
  - Steel components: To BS EN 13438.
  - Safety standards: To British Coatings Federation 'Code of safe practice - Application of thermosetting powder coatings by electrostatic spraying'.

220 POWDER COATING APPLICATORS

- Applicator requirements:
  - Approved by powder coating manufacturer.
  - Currently certified to BS EN ISO 9001.
  - Comply with quality procedures, guarantee conditions, standards and tests required by powder coating manufacturer.
  - Applicator to use only one plant.
  - Selected applicator: Submit details before commencement of powder coating including:
    Name and contact details.
    Details of accreditation schemes.

225 GUARANTEES

- Powder coating manufacturer and applicator guarantees:
  - Submit sample copies before commencement of powder coating.
  - Submit signed project specific copies on completion of work.

230 CONTROL SAMPLES

- Sequence: Prior to ordering materials for the works, obtain approval of appearance for:
  - Powder coated samples: Of various grades and forms of background metal to be used, showing any colour, texture and gloss variation.
  - Fabrication samples: Showing joint assembly, how powder coating is affected and how any cut metal edges are finished and protected.
- Samples to include the following information:
  - Product reference.
  - Colour.
  - Reference number.
  - Name.
  - Gloss level.

235 INDEPENDENT INSPECTION AT PLANT

- Requirement: Contractors/ suppliers of the following designated components must commission an approved Independent Inspection Authority to carry out acceptance inspections to confirm that powder coating application complies with this specification.

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  - Designated components: all as indicated on drawings.
- Acceptance inspections: Carry out for each variation of colour and finish of each component work package at applicator's plant prior to any fabrication of units, in accordance with the following:
  - Where three of more production runs are required for application of coatings, not less than three acceptance inspections must be carried out in accordance with BS 6001-1, general inspection level 2, with an acceptance quality limit of 1%.
  - Where less than three production runs are required for application of coatings, one acceptance inspection must be carried out in accordance with BS 6001-2, with a limiting quality of 5% where the probability of acceptance is 10%.
- Components failing inspection: Reprocess or replace and reinspect.
- Inspection reports: Independent Inspection Authority must submit copies.

240 QUALITY ASSURANCE SYSTEM

- Requirement: Powder and coating application to the following designated components is to be tested and approved in accordance with the Qualicoat system.
  - Designated components: all.

250 COMPONENT DESIGN

- Condition of components to be powder coated:
  - To comply with relevant recommendations of BS 4479-1, -3, and -4.
  - Of suitable size to fit plant capacity.
  - Of suitable thickness to withstand oven curing.

310 PRETREATMENT OF ALUMINIUM COMPONENTS

- Condition of components to be pretreated:
  - Free from corrosion and damage.
  - All welding and jointing completed and finish off as specified.
  - Free from impurities including soil, grease, oil.
  - Suitable for and compatible with the pretreatment process.
- Conversion coating requirements:
  - Chromate system: To BS 6496 or BS EN 12206-1.
  - Chromate-free system: To BS EN 12206-1. Submit details before using.
- Rinsing requirements: Use demineralized water. Drain and dry.

320 PRETREATMENT OF STEEL COMPONENTS

- Condition of components to be pretreated:
  - Free from corrosion and damage.
  - All welding and jointing completed and finish off as specified.
  - Free from impurities including soil, grease, oil.
  - Suitable for and compatible with the pretreatment process.
- Conversion coating requirements: To BS EN 13438.
- Rinsing requirements: Use demineralized water. Drain and dry.

430 EXTENT OF POWDER COATINGS

- Application: To visible component surfaces, and concealed surfaces requiring protection. Coated surfaces will be deemed 'significant surfaces' for relevant BS 6496 or BS EN 13438 performance requirements.

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430A EXTENT OF POWDER COATINGS

- Application: To visible component surfaces, and concealed surfaces requiring protection. Coated surfaces will be deemed 'significant surfaces' for relevant EN ISO12206 or BS EN 13438 performance requirements.

435 APPLICATION OF POWDER COATINGS

- Surfaces to receive powder coatings: Free from dust or powder deposits.
- Powder colours: Obtain from one batch of one manufacturer.
- Commencement of powder coating: To be continuous from pretreatment.
- Jig points: Not visible on coated components.
- Curing: Controlled to attain metal temperatures and hold periods recommended by powder coating manufacturer.
- Stripping and recoating of components: Only acceptable by prior agreement of powder coating manufacturer. Stripping, pretreatment and powder coating are to be in accordance with manufacturer's requirements.
- Overcoating of components: Not acceptable.

441 PERFORMANCE AND APPEARANCE OF POWDER COATINGS

- For aluminium components:
  - Standard: To BS EN 12206-1.
  - European Qualicoat: Certificate: Class 3 for high performance powder coating and Class 2 for super durable polyester powder coating.
  - AAMA: 2605 for high performance powder coating and 2604 for super durable polyester powder coating.
  - Total system Warranty: 30 years for high performance powder coating and 25 years for super durable polyester powder coating.
  - Minimum thickness: not less than 60 microns.
- For steel components:
  - Standard: To BS EN 13438.
  - GSB Certificate: Class A.
- Visual inspection after powder coating: Significant surface viewing distances to be as specified in the relevant Standard, unless specified otherwise.
- Colour and gloss levels: To conform with approved samples.

445 HIGH PERFORMANCE COATING (PVDF)

- Superior-Performance Organic Finish, Four-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat.

  - Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.

- Color and Gloss: As selected by Engineer from manufacturer's full range.

- High-Performance Powder: Manufacturer's standard 1-coat, thermocured system consisting of specially formulated fluoropolymer powder. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with AAMA 2605 and with coating and resin manufacturers' written instructions.

  - Color and Gloss: As selected by Engineer from manufacturer's full range.

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450 ALUMINIUM ALLOY FABRICATIONS

- Units may be assembled:
  - Before powder coating.
  - From components powder coated after cutting to size.
  - Where approved, from components powder coated before cutting to size.
- Exposure of uncoated background metal: Not acceptable.
- Assembly sealants: Compatible with powder coatings. Obtain approval of colour if sealants are visible after fabrication.

460 STEEL FABRICATIONS

- Unit assembly: Wherever practical, before powder coating.
- Exposure of uncoated background metal: Not acceptable.
- Assembly sealants: Compatible with powder coatings. Obtain approval of colour if sealants are visible after fabrication.

470 FIXINGS

- Exposed metal fixings: Powder coat together with components, or coat with matching repair paint system applied in accordance with the powder coating manufacturer's recommendations.

480 DAMAGED COMPONENTS - REPAIR/ REPLACEMENT

- Before delivery to site: Check all components for damage to powder coatings. Replace damaged components.
- Site damage: Submit proposals for repair or replacement.

510 PROTECTION

- Powder coated surfaces of components: Protect from damage during handling and installation, or by subsequent site operations.
- Protective coverings: Must be:
  - Resistant to weather conditions.
  - Partially removable to suit building in and access to fixing points.
- Protective tapes in contact with powder coatings: Must be:
  - Low tack, self-adhesive and light in colour.
  - Applied and removed in accordance with tape and powder coating manufacturers' recommendations. Do not use solvents to remove residues as these are detrimental to the coating.
- Inspection of protection: Carry out monthly. Promptly repair any deterioration or deficiency.

535 DOCUMENTATION

- Submit the following information for each batch of powder coated components:
  - Supplier.
  - Trade name.
  - Colour.
  - Type of powder.
  - Method of application.
  - Batch and reference number.
  - Statutory requirements.
  - Test certificates.
  - Maintenance instructions.

540 COMPLETION

- Protection: Remove.

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- Cleaning and maintenance of powder coatings: Carry out in accordance with procedures detailed in powder coating manufacturer and applicator guarantees.

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Z210A - PIPELINES AND PIPEWORK - HVAC

210A.005 SUMMARY

- This section includes specs for piping applicable for:
    - Hydronic piping

210A.020 CARBON STEEL PIPES AND FITTINGS:

- Application: Refer to clause 210A.075 “PIPEWORK APPLICATION”
- Pipes and Tubes
    - Seamless carbon steel tubes
        - To BS EN 10255
            - Size - nominal diameter (DN) up to and including 150mm.
            - Black, heavy – Reference Y10.2010A
            - Black, medium – Reference Y10.2010B
        - To BS EN 10216-1
            - Reference Y10.2030
            - Wall thickness - to be suitable for the application duty / testing requirements.
- Fittings
    - Butt welding carbon steel fittings.
        - Size range - 25mm to 400mm.
        - To BS EN 10253-1 for general use in non-pressure piping applications without specific inspection requirements - reference Y10.2060A
        - To BS EN 10253-2 with specific inspection requirements for use on pressure piping applications covered by the Pressure Equipment Regulations - reference Y10.2060B
    - Malleable cast iron fittings, screwed
        - Size range - 10mm to 164mm.
        - Reference Y10.2070#
        - Finish
            - Black
            - Galvanised
    - Wrought Steel threaded pipe fittings
        - Type
            - Seamless fittings manufactured from seamless tube, forging or rolled bar.
            - Fabricated fittings manufactured from welded tube or where welding forms part of the fabrication of the fitting.

- Reference Y10.2090
- Size range - 6mm to 150mm.

- Fittings, grooved for mechanical joints

- Size range - 20mm to 600mm.
- Galvanised cast iron - reference Y10.2080E
- Painted steel - reference Y10.2080F

- Joints

- Up to and including 50mm

- Screwed for threaded end
- Mechanical joint for grooved end

- 65mm and above

- Welded
- Flanged
- Mechanical joint for grooved end

- Jointing materials

- Circular flanges

- Flanges to BS EN 1092-1 and BS ISO 7005-1
- Type

- Welding flanges - reference Y10.3010A

- Jointing rings for circular flanges

- Non-metallic flat for flanges to BS EN 1092-1 - reference Y10.3020A
- Metallic for flanges to BS EN 1092-1 - reference Y10.3020B

- Screwed joints to relevant parts of BS EN 10226

- Reference Y10.3030A
- Where chemical cleaning is required - reference Y10.3030C

- Union connections

- Low pressure applications - Railroad pattern - spherical seating bronze to iron.
- High pressure applications - Navy pattern - spherical seating bronze to bronze.

- Welding rods - Reference Y10.3050A

210A.030 COPPER PIPES AND FITTINGS:

- Application: Refer to clause 210A.075 “PIPEWORK APPLICATION”
- Pipes

- Copper pipe, soft (Class Y) - Reference Y10.2280#
- Copper pipe, half hard (Class X) - Reference Y10.2270#
- Copper pipe, hard (Class Z) - Reference Y10.2290#
- Pipe to be as recommended by supplier.

- Fittings

  - Capillary fittings for copper tubing - Reference Y10.2310#
  - Compression fittings for copper tubing - Reference Y10.2320#

- Jointing materials

  - Welding rods - Reference Y10.3050A
  - Brazed joints - to BS EN ISO 17672
  - Capillary joints - Reference Y10.3070#

210A.050 PLASTICS PIPES AND FITTINGS:

- Application: Refer to clause 210A.075 “PIPEWORK APPLICATION

  - UPVC (Solid-Wall) to BS EN 1329

    - Pipes - Reference Y10.2580A
    - Fittings - Reference Y10.2585A

210A.062 PRE-INSULATED UNDERGROUND PIPELINES:

- Application: Refer to clause 210A.075 “PIPEWORK APPLICATION”
- Type - Bonded single steel service pipes to BS EN 253 - reference Y10.2880
- Provide a complete installation capable of performing within the specified design conditions for the duration of the systems design life.
- The system shall be fully in accordance with the recommendations and instructions of the pipe component manufacturer.
- The distribution of force and pipe movement for the whole piping system shall be fully assessed and a complete system installed including all required expansion facilities.
- Maximum resultant stresses and movements shall be considered at all critical positions in the proposed piping system. Critical positions shall include anchors, bends, branches and building entries.
- All loading conditions shall be considered in order to ensure that maximum values of resultant stress and movement have been established. The effect of structural discontinuities and pipeline supports shall be taken account of in the design and installation.
- The contractor shall liaise with all other utilities in the design and selection of final routes. Details of equipment, pipework and the distribution system layout indicated on the layout drawing(s) are approximate.
- Materials - distribution mains

  - Carrier pipe - Steel
  - Thermal insulation

    - Polyurethane foam (PU)
    - Thermal conductivity to be in accordance with BS EN 253

- Outer casing - polyethylene (PE).

- Provide leak detection system and alarm monitoring

210A.070 PIPEWORK ACCESSORIES:

- Masking plates (Escutcheons)
  - Application: Wall masking plates
    - Chromium plated - reference Y10.3190A.
    - Plastic - reference Y10.3190B
    - Pipe rings and clips
  - Application: Floor and ceiling masking plates
    - Chromium plated - reference Y10.3190A.
    - Plastic - reference Y10.3190B
    - Pipe rings and clips
- Copper pipework clips:
  - Use brass pipe clips.

210A.077 PIPEWORK APPLICATION: HYDRONIC PIPING

- General
  - Working pressure : as designed.
  - Working temperature :as designed.
- Chilled water / Heating Water Piping Inside Buildings
  - Pipes and tubes:
    - Up to and including 50 mm
      - Seamless medium black steel tubes to BS EN 10255
    - 65 mm up to and including 150 mm
      - Seamless medium black steel tubes, grooved end to BS EN 10255
    - 200 mm and above up
      - Seamless black steel tubes to BS EN 10216-1
      - Material grade P235TR2
  - Fittings
    - Up to and including 50 mm
      - Malleable cast iron fittings, screwed

        - Finish
            - Black
        - 65 mm and above
            - Grooved end carbon steel fittings.
    - Joints
        - Up to and including 50 mm
            - Screwed for threaded end
        - 65 mm and above
            - Mechanical joints for grooved end
- External underground Chilled water / Heating Water Piping
    - Pipes and tubes - Pre-insulated, bonded single steel service pipes to BS EN 253
    - Provide leak detection system and alarm monitoring
- AC condensate drain piping:
    - Pipes and tubes:
        - UPVC (Solid-Wall) to BS EN 1329

210A.080 GENERAL WORKMANSHIP:

- Appearance - reference Y10.4010
- Spacing - reference Y10.4020
- Gradients - reference Y10.4030
- Air venting requirements
    - Air bottles - reference Y10.4040A
    - Automatic air vents - reference Y10.4040B
- Drain requirements - reference Y10.4050
- Expansion and contraction - reference Y10.4060
- Pipe fittings
    - Bends/swept tees
    - Elbows/square tees
    - Reference Y10.4070#
- Pipes through walls and floors - reference Y10.4110
- Protect pipework penetrating fire separating elements in accordance with, Building Regulations, BS 9999 and BESA Technical Bulletin TB/032.
- Pipe sleeves
    - Where Insulation not carried through pipe sleeve - Reference Y10.4120A
    - Where Insulation carried through pipe sleeve - reference Y10.4120B

- Connect to equipment.
- Use distribution headers.
- Temporary plugs, caps and flanges - Reference Y10.4150A.
- Flanged joints general - reference Y10.4160
- Dissimilar metals - reference Y10.4170
- Pipe rings and clips - reference Y10.4180
- Anchors - reference Y10.4190
- Slide guides - reference Y10.4200
- Pipe supports - reference Y10.4205

    - Comply with the manufacturers' installation recommendations for the following proprietary pipe systems:

        - Press-fit and push-fit pipework systems using thin wall carbon steel, stainless steel or copper.
        - Systems using grooved mechanical joints.
        - Plastic pipe systems.

- Support spacing

    - Tables for steel, copper, iron, PVC and ABS pipes - reference Y10.4220
    - Comply with tables in appropriate parts of BESA TR/20.
    - For the following proprietary pipe systems comply with the manufacturers' installation recommendations:

        - Press-fit and push-fit pipework systems using thin wall carbon steel, stainless steel or copper.
        - Systems using grooved mechanical joints.
        - Plastic pipe systems.

- Isolation and regulation - Reference Y10.4230A
- Maintenance and renewal - reference Y10.4240
- Clean by removing cement and clean off all pipework and brackets.
- Non-ferrous components - thoroughly clean and degrease.
- Pipe collars (closers) for plastic pipes

    - Type

        - Stainless steel collar with fixing brackets with intumescent liner.
        - Pre-assembled wrap for casing within concrete floor or masonry wall.

    - Fire resistance

        - 2 hrs

    - Installation to be in accordance with the manufacturer's instructions and grouted/sealed using the manufacturer's proprietary compound/sealant.
    - Standards - Test to BS EN 1366-3 and BS EN 1363-1.

210A.090 WORKMANSHIP, STEEL PIPEWORK:

- Welding, general

    - Class 1 - reference Y10.5010A (Weld pipeline joints to BS 2633)

    - Class 2 - reference Y10.5010B (Weld pipeline joints to BS 2971)

- Welded joints - reference Y10.5020
- Painting welded joints - reference Y10.5030
- Flanged joints - reference Y10.5040
- Screwed joints - reference Y10.5050
- Mechanical joints - reference Y10.5060
- Anchors

    - U-bolts - reference Y10.5070A
    - Flanges - reference Y10.5070B

- Pipework painting - reference Y10.5090
- Installation of stainless-steel pipework

    - Compression joints - reference Y10.5100
    - Mechanical joints - Y10.5060

210A.100 WORKMANSHIP, COPPER PIPEWORK:

- Compression joints - reference Y10.6030
- Capillary joints - reference Y10.6040
- Anchors

    - Flanges - reference Y10.6060A
    - Saddle clamps - reference Y10.6060B

210A.120 WORKMANSHIP, PLASTIC PIPES:

- Installation of thermoplastic piping for soil and waste discharge inside buildings and buried in ground within the building - reference Y10.8005
- Solvent welded joints, PVC - reference Y10.8010

210A.140 WORKMANSHIP UNDERGROUND/BURIED PIPEWORK:

- Protection of underground pipework - reference Y10.9030
- Protection of buried pipes – Reference Y10.9040#
- Protection of pipes in screed

    - Wrap with two protective tapes before laying.
    - Sheath with PVC.

- Thermally insulated underground pipelines - Reference Y10.9060#

210A.150 WORKMANSHIP MISCELLANEOUS:

- Flexible couplings and flange adapters, sleeve type - reference Y10.9010
- Corrosion protective tape - reference Y10.9100
- Mechanical protective tape - reference Y10.9110
- Steelwork painting - Reference Y10.9120#

Z210B - PIPELINES AND PIPEWORK - PLUMBING

210B.005 SUMMARY

- This section includes specs for piping applicable for:
    - Domestic water pipework
    - Sanitary drainage, vent and storm drainage piping
    - Instrument Air (Compressed Air)

210B.020 CARBON STEEL PIPES AND FITTINGS:

- Application: Refer to clause 210B.075 “PIPEWORK APPLICATION”
- Pipes and Tubes
    - Seamless carbon steel tubes
        - To BS EN 10255
            - Galvanised, heavy – Reference Y10.2010D
            - Galvanised, medium – Reference Y10.2010C
            - Galvanised, heavy, grooved ends – Reference Y10.2010G
            - Galvanised, medium, grooved ends – Reference Y10.2010H
        - To BS EN 10216-1
            - Reference Y10.2030
            - Wall thickness - to be suitable for the application duty / testing requirements.
- Fittings
    - Butt welding carbon steel fittings.
        - Size range - 25mm to 400mm.
        - To BS EN 10253-1 for general use in non-pressure piping applications without specific inspection requirements - reference Y10.2060A
        - To BS EN 10253-2 with specific inspection requirements for use on pressure piping applications covered by the Pressure Equipment Regulations - reference Y10.2060B
    - Malleable cast iron fittings, screwed
        - Size range - 10mm to 164mm.
        - Reference Y10.2070#
        - Finish
            - Black
            - Galvanised
    - Wrought Steel threaded pipe fittings
        - Type

- Seamless fittings manufactured from seamless tube, forging or rolled bar.
- Fabricated fittings manufactured from welded tube or where welding forms part of the fabrication of the fitting.

- Reference Y10.2090
- Size range - 6mm to 150mm.

- Fittings, grooved for mechanical joints

- Size range - 20mm to 600mm.
- Galvanised cast iron - reference Y10.2080E
- Painted steel - reference Y10.2080F

- Joints

- Up to and including 50mm

- Screwed for threaded end
- Mechanical joint for grooved end

- Jointing materials

- Circular flanges

- Flanges to BS EN 1092-1 and BS ISO 7005-1
- Type

- Welding flanges - reference Y10.3010A

- Jointing rings for circular flanges

- Non-metallic flat for flanges to BS EN 1092-1 - reference Y10.3020A
- Metallic for flanges to BS EN 1092-1 - reference Y10.3020B

- Screwed joints to relevant parts of BS EN 10226

- Reference Y10.3030A
- Where chemical cleaning is required - reference Y10.3030C

- Union connections

- Low pressure applications - Railroad pattern - spherical seating bronze to iron.
- High pressure applications - Navy pattern - spherical seating bronze to bronze.

- Welding rods - Reference Y10.3050A

210B.040 CAST/DUCTILE IRON PIPES AND FITTINGS:

- Application: Refer to clause 210B.075 “PIPEWORK APPLICATION”
- Pipes

- Ductile iron pipes for water applications to BS ISO 2531

- Flanged joints - reference Y10.2425A
- Spigot and socket joints - reference Y10.2425B
- Push-in self anchor joints

- Jointing materials
  - Flanges to BS EN 1092-2
  - Couplings
    - Material
      - Black ductile iron
    - Gasket - EPDM
  - Spigot/socket caulked joints for ductile iron pipes - Reference Y10.3110A

210B.050 PLASTICS PIPES AND FITTINGS:

- Application: Refer to clause 210B.075 "PIPEWORK APPLICATION"
- Pressure pipes for drainage to BS EN 15014 – Reference Y10.2442
  - UPVC to BS EN 1452
    - Size Range: 12 - 1000 mm
    - Pipes - Reference Y10.2455A
    - Fittings - Reference Y10.2475A
- Pressure pipes for cold and hot water and heating systems inside buildings to BS ISO 10508
  - PP to BS EN ISO 15874
    - Size Range: 12-250 mm
    - Reference Y10.2595
- Plastic rainwater piping systems comprising pipes, fittings and brackets for above ground external use to BS EN 12200-1
  - Pipe material
    - Solid wall PVC-U.
    - Multi-layer with acrylic outer layer and fittings
  - Pipe type / details
    - Circular
- Jointing equipment for polybutylene pipes
  - Compression fittings - provide the equipment recommended by the manufacturer to carry out compression jointing on polybutylene pipes and fittings.

- Socket fusion - provide the equipment recommended by the manufacturer to carry out socket fusion jointing on polybutylene pipes and fittings.
- Electrofusion - provide the equipment recommended by the manufacturer to carry out electrofusion jointing on polybutylene pipes and fittings.

210B.070 PIPEWORK ACCESSORIES:

- Masking plates (Escutcheons)
  - Application: Wall masking plates
    - Chromium plated - reference Y10.3190A.
    - Plastic - reference Y10.3190B
    - Pipe rings and clips
  - Application: Floor and ceiling masking plates
    - Chromium plated - reference Y10.3190A.
    - Plastic - reference Y10.3190B
    - Pipe rings and clips

210B.075 PIPEWORK APPLICATION: DOMESTIC WATER PIPING

- Above Ground water distribution pipe works:
  - PP to BS EN ISO 15874
    - Type
      - PP-R (type 3)
    - Piping running in plenums and concealed spaces shall be plenum-rated piping where pipes are to be wrapped with fire resistant plenumwrap blanket, and/or insulated with fiberglass or mineral-wool pipe insulation, and field installed.
    - System is to have a flame-spread index of less than 25 and smoke-developed index of less than 50 to ASTM E84 or UL 2846; or Class B-S2 d0 rating in accordance with EN 13823.
    - For insulation required for thermal and condensation reasons, see Section Z250b.
    -

210B.076 PIPEWORK APPLICATION: SANITARY WASTE, VENT AND STORM DRAINAGE PIPING

- Aboveground, Soil, Waste, and Vent pipe works:
  - UPVC (Solid-Wall) to BS EN 1329
  - PE to BS EN 1519 for Kitchens and laundry
- Underground, Soil, Waste, and Vent pipe works:
  - Gasket – EPDM
  - PE to BS EN 1519.

- Aboveground, Rainwater drainage pipe works:
    - Plastic piping to BS EN 12200
        - Pipe material
            - Solid wall PVC-U.
        - Pipe type / details
            - Circular
- Aboveground, External, Rainwater drainage pipe works:
    - UPVC (Solid-Wall) to BS EN 1329
- Aboveground, Sewage Force Mains pipe works:
    - Ductile Iron
        - Ductile Iron to BS ISO 2531
        - Joints - Push-in self anchor joints
- Underground, Sewage Force Mains pipe works:
        - Gasket – EPDM
    - PE to BS EN 1519.

210B.077 PIPEWORK APPLICATION: INSTRUMENT AIR (COMPRESSED-AIR) PIPING

- Compressed-Air piping:
    - Galvanised Steel
        - Pipes and tubes:
            - Seamless medium galvanised steel tubes to BS EN 10216-1
            - Seamless medium galvanised steel tubes, grooved ends to BS EN 10216-1
            - Material grade P235TR2
        - Fittings
            - Up to and including 50 mm
                - Malleable cast iron fittings, screwed
                    - Finish Galvanised
                - Wrought Steel threaded pipe fittings
                    - Type - Fabricated fittings manufactured from welded tube or where welding forms part of the fabrication of the fitting.

- 65 mm up and above
    - Butt welding carbon steel fittings.
    - Fittings, grooved for mechanical joints
- Joints
    - Up to and including 50 mm - Screwed
    - 65 mm and above
        - Mechanical joint for grooved end

- Drain Piping:
    - UPVC (Solid-Wall) to BS EN 1329

210B.080 GENERAL WORKMANSHIP:

- Appearance - reference Y10.4010
- Spacing - reference Y10.4020
- Gradients - reference Y10.4030
- Air venting requirements
    - Air bottles - reference Y10.4040A
    - Automatic air vents - reference Y10.4040B
- Drain requirements - reference Y10.4050
- Expansion and contraction - reference Y10.4060
- Pipe fittings
    - Bends/swept tees
    - Elbows/square tees
    - Reference Y10.4070#
- Pipes through walls and floors - reference Y10.4110
- Protect pipework penetrating fire separating elements in accordance with, Building Regulations, BS 9999 and BESA Technical Bulletin TB/032.
- Pipe sleeves
    - Where Insulation not carried through pipe sleeve - Reference Y10.4120A
    - Where Insulation carried through pipe sleeve - reference Y10.4120B
- Connect to equipment.
- Use distribution headers.
- Temporary plugs, caps and flanges - Reference Y10.4150A.
- Flanged joints general - reference Y10.4160
- Dissimilar metals - reference Y10.4170
- Pipe rings and clips - reference Y10.4180
- Anchors - reference Y10.4190
- Slide guides - reference Y10.4200
- Pipe supports - reference Y10.4205
    - Comply with the manufacturers' installation recommendations for the following proprietary pipe systems:

        - Press-fit and push-fit pipework systems using thin wall carbon steel, stainless steel or copper.
        - Systems using grooved mechanical joints.
        - Plastic pipe systems.

- Support spacing

    - Tables for steel, copper, iron, PVC and ABS pipes - reference Y10.4220
    - Comply with tables in appropriate parts of BESA TR/20.
    - For the following proprietary pipe systems comply with the manufacturers' installation recommendations:

        - Press-fit and push-fit pipework systems using thin wall carbon steel, stainless steel or copper.
        - Systems using grooved mechanical joints.
        - Plastic pipe systems.

- Isolation and regulation - Reference Y10.4230A
- Maintenance and renewal - reference Y10.4240
- Clean by removing cement and clean off all pipework and brackets.

    - PP-R Piping System: Materials and chemical concentrations used shall comply with the pipe and accessory manufacturers' recommendations and shall be in accordance with applicable third-party standards and regulatory authority requirements. PP-RCT pipes system disinfection accordance with pipe manufacturer limits

- Non-ferrous components - thoroughly clean and degrease.
- Pipe collars (closers) for plastic pipes

    - Type

        - Stainless steel collar with fixing brackets with intumescent liner.

    - Fire resistance

        - [2 hrs]

    - Installation to be in accordance with the manufacturer's instructions and grouted/sealed using the manufacturer's proprietary compound/sealant.
    - Standards - Test to BS EN 1366-3 and BS EN 1363-1.

210B.090 WORKMANSHIP, STEEL PIPEWORK:

- Welding, general

    - Class 1 - reference Y10.5010A (Weld pipeline joints to BS 2633)
    - Class 2 - reference Y10.5010B (Weld pipeline joints to BS 2971)

- Welded joints - reference Y10.5020
- Painting welded joints - reference Y10.5030
- Flanged joints - reference Y10.5040
- Screwed joints - reference Y10.5050
- Mechanical joints - reference Y10.5060
- Anchors

    - U-bolts - reference Y10.5070A
    - Flanges - reference Y10.5070B

- Pipework painting - reference Y10.5090
- Installation of stainless-steel pipework

    - Compression joints - reference Y10.5100
    - Mechanical joints - Y10.5060

210B.110 WORKMANSHIP, CAST/DUCTILE IRON:

- Flanged joints - reference Y10.7010
- Caulked joints - reference Y10.7020
- Flexible joints - reference Y10.7030

210B.120 WORKMANSHIP, PLASTIC PIPES:

- Installation of thermoplastic piping for soil and waste discharge inside buildings and buried in ground within the building - reference Y10.8005
- Installation of thermoplastic polybutylene and cross-linked polyethylene piping for heating systems - reference Y10.8006
- Solvent welded joints, PVC - reference Y10.8010
- Fusion joints, PE - Reference Y10.8020
- Mechanical fittings, PE - reference Y10.8030
- Anchors, PVC - reference Y10.8040
- Jointing polybutylene pipes and fittings - reference Y10.8050
- Plastic pipes and fittings with secondary containment and fittings for underground fuel oil systems - reference Y10.8070.

210B.140 WORKMANSHIP UNDERGROUND/BURIED PIPEWORK:

- Protection of underground pipework - reference Y10.9030
- Protection of buried pipes – Reference Y10.9040#
- Protection of pipes in screed

    - Wrap with two protective tapes before laying.
    - Sheath with PVC.

- Thermally insulated underground pipelines - Reference Y10.9060#

210B.150 WORKMANSHIP MISCELLANEOUS:

- Flexible couplings and flange adapters, sleeve type - reference Y10.9010
- Corrosion protective tape - reference Y10.9100
- Mechanical protective tape - reference Y10.9110
- Steelwork painting - Reference Y10.9120#

Z211A - PIPELINE ANCILLARIES - HVAC

211A.010 GENERAL:

- Comply with work section general clauses below
    - Safety and relief valves, self-operated, application - reference Y11.1010
- For applicable valves comply with BS EN 16668 for all essential safety requirements of the Pressure Equipment (Safety) Regulations. Valves excluded from conformance to this standard in the Regulations shall meet "sound engineering practice" by conformity to the relevant product standard.
- Face to face and centre to face dimension of PN and Class designated flanged metal valves to be in accordance with BS EN 558
- Testing of valves
    - Pressure test metallic valves at manufacturer's works, in accordance with BS EN 12266-1 or BS ISO 5208 in conjunction with given specific requirements of the valve product or performance standard.
    - Undertake supplementary tests below in accordance with BS EN 12266-2 in conjunction with given specific requirements of the valve product or performance standard
        - Obturator strength
        - Back seat tightness
        - Operability
        - Anti-static design at 12V
        - Anti-static design at 100V
        - Fire tested design
        - Flow resistance
    - Pressure test thermoplastic valves at manufacturer's works, in accordance with BS ISO 9393-1 in conjunction with given specific requirements of the valve product or performance standard.
- Supply valves as specified in work section
- Supply valves as schedule reference
- Supply local controls as schedule reference

211A.030 STOP VALVES:

- Type : provide selection.
- Service fluid
    - Water
- Operating temperature : as designed.
-
- PN to suit system maximum working pressure.
- Comply with WRAS requirements for water services applications.
- CE certified and Kitemark compliant.
- Pipe material
    - To suit copper tube.
    - To suit plastic tube.
    - To suit steel tube.

- Copper alloy gate valves for general use to BS EN 12288
    - Screwed to BS EN ISO 228-1, or ISO 7-1 - reference Y11.2020A
    - Compression to BS EN 1254-2 - reference Y11.2020B
    - Flanged to BS EN 1092-3 - reference Y11.2020C
    - Loose nut/union end - reference Y11.2020D
- Cast iron gate valves for general use to BS EN 1171
    - Grey cast iron flanged to BS EN 1092-2 - reference Y11.2030A
- Copper alloy globe valves for general use to BS 5154 and BS EN 12288
    - Screwed to relevant parts of BS EN 10226 - reference Y11.2040A
    - Flanged to BS EN 1092-3 - reference Y11.2040B
    - Compression to BS EN 1254-2 - reference Y11.2040C
    - Compression to BS EN 1254-3 - reference Y11.2040D
- Cast iron globe valves for general use to BS EN 13789
    - Grey cast iron flanged to BS EN 1092-2 - reference Y11.2050A
- Steel parallel slide for steam and other high temperature / pressure applications to BS EN 1984
    - Reference Y11.2060A
- Steel wedge type gate valve for general use to BS EN 1984
    - Flanged to BS EN 1092-1 - reference Y11.2070A
    - Threaded - reference Y11.2070D
    - Auxiliary connections
- Ball valves
    - Application, standard and material
        - General purpose heating, cooling and other applications - copper alloy to BS EN 13547.
        - Gas - to BS EN 331.
    - Screw driver/key operated
        - Screwed to relevant parts of BS EN 10226 - reference Y11.2080A
        - Compression to BS EN 1254-2 - reference Y11.2080B
    - Lever operated
        - Screwed to relevant parts of BS EN 10226 - reference Y11.2080C
        - Compression to BS EN 1254-2 - reference Y11.2080D
    - Lockshield
        - Screwed to relevant parts of BS EN 10226 - reference Y11.2080E
        - Compression to BS EN 1254-2 - reference Y11.2080F
- Butterfly valves for general use to BS EN 593
    - Semi-lugged between flanges to BS EN 1092-2
        - Lever operated - reference Y11.2090A
        - Gear operated - reference Y11.2090B

- Between mechanical joints
    - Lever operated - reference Y11.2090C
    - Gear operated - reference Y11.2090D
- Fully-lugged to BS EN 593 - reference Y11.2090E
    - Lever operated.
    - Gear operated.
- Key operated type A - reference Y11.2110A
- Closed bottom taper plug valves for gas installations for buildings to BS EN 331.

211A.040 REGULATING VALVES:

- Type: provide selection
- Service fluid
    - Wate
- Operating temperature: as designed.
- PN to suit system maximum working pressure.
- Comply with WRAS requirements.
- CE certified and Kitemark compliant.
- Pipe material
    - To suit copper tube.
    - To suit plastic tube.
    - To suit steel tube.

211A.050 DOUBLE REGULATING VALVES:

- Type: provide selection
- Service fluid
    - [Water]
- Operating temperature: as designed
- PN to suit system maximum working pressure.
-
- Comply with WRAS requirements.
- CE certified and Kitemark compliant.
- Pipe material
    - To suit copper tube.
    - To suit plastic tube.
    - To suit steel tube.
- Butterfly type to BS EN 593
    - Between flanges to BS EN 1092-2
        - Lever operated - reference Y11.2210A
        - Gear operated - reference Y11.2210B
    - Between mechanical joints

        - Lever operated - reference Y11.2210C
        - Gear operated - reference Y11.2210D
    - Globe valves to BS 7350, section 3.1.
        - Copper alloy
            - Screwed to relevant parts of BS EN 10226 - reference Y11.2220A
            - Flanged to BS EN 1092-2 - reference Y11.2220B
        - Cast iron
            - Flanged to BS EN 1092-2 - reference Y11.2220C

211A.060 FLOW MEASUREMENT VALVES:

- Type :provide selection
- Service fluid
    - Water
- Operating temperature: as designed
- PN to suit system maximum working pressure.
- Provide expansion devices / bellows as schedule reference Expansion Bellows and Flexible Hose Compensators
- Comply with WRAS requirements.
- CE certified and Kitemark compliant.
- Pipe material
    - To suit copper tube.
    - To suit plastic tube.
    - To suit steel tube.
    - Flow measurement devices to BS 7350
        - Section 3.2 Type 3
            - Copper alloy
                - Screwed to relevant parts of BS EN 10226 - reference Y11.2230A
                - Flanged to BS EN 1092-3 - reference Y11.2230B
            - Cast iron
                - Flanged to BS EN 1092-2 - reference Y11.2230]
        - Section 3.2 Type 4
            - Copper alloy
                - Screwed to relevant parts of BS EN 10226 - reference Y11.2230E
                - Flanged to BS EN 1092-3 - reference Y11.2230F
            - Cast iron - reference Y11.2230G
    - Variable orifice valve

- Fixed orifice valve

211A.065 PRESSURE INDEPENDENT CONTROL VALVES (PICV'S):

- Select, install and commission valves to provide the functions of flow limitation or modulating and differential pressure control within a single valve body.
- Commission valves in accordance with the manufacturer's recommendations and Commissioning Specialists Association TM18.
- The valve manufacturer shall provide test results for each type and size of PICV to be used on the project in accordance with BSRIA Test Method for Pressure Independent Control Valves BTS 1/2012.
- Incorporate a flushing drain in the pipework between the terminal unit and the PICV.
- Type
    - Full stroke constant k_V where the control and flow setting functions are separated within the valve and the full stroke of the valve is available for control.
    - Full stroke variable k_V where the control valve section has a constant unchangeable stroke distance but its k_V can be varied by means of an inlet port with an adjustable opening size.
    - Stroke limited variable k_V where the control valve and flow setting devices are combined in a single component.
    - Globe.
    - Rotary, characterised ball.
- Valve characteristic/control function
    - Linear (modulating).
    - Equal percentage (modulating).
- Application
    - Cooling terminal units
    - Heating and cooling terminal units
- Duties
    - To suit terminal unit design flow rates as detailed in equipment schedules
    - Duties and details as schedule reference Motorised Control Valves
- Standard
    - Relevant parts of BS EN 60534
    - Valve leakage class to BS EN 60534-4 when shut off.
- Maximum pressure differential (kPa) as per design
- Minimum operating pressure differential for PICV operation (kPa) as per design
- Materials
    - Body - DZR brass.
    - Globe or ball - brass.
    - Stem - brass.
    - O-Ring/diagram - EPDM rubber.
    - Springs - stainless steel.
- Features
- Facility to measure pressure drop across valves at commissioning.
- Actuator
    - 0-10V proportional electric for modulating control.

- 3 point floating control.
- Prefabricated packaged valve assembly requirements
    - Type of heating/cooling terminal:
        - Air handling units
    - Fan coil units Components required:
        - PICV.
        - Ball type isolation valves on flow and return.
        - Flushing blow down drain valve.
        - Flow measurement venturi for commissioning verification.
    - Component to be pre-assembled and tested at the manufacturer's works, test pressure (kPa)
    -
- Labeling requirements

211A.070 FLOW REGULATORS AND COMBINATION VALVES:

- Type : provide selection
- Service fluid
    - Water
- Operating temperature: as designed
- PN to suit system maximum working pressure.
- Comply with WRAS requirements.
- CE certified and Kitemark compliant.
- Pipe material
    - To suit copper tube.
    - To suit plastic tube.
    - To suit steel tube.

211A.075 HEAT METERS:

- Type: provide selection
- Standards
    - Meters - BS EN 1434-1, BS EN 1434-2, BS EN 1434-3, BS EN 1434-4, BS EN 1434-5
    - Heat meter installation commissioning, operational monitoring and maintenance - BS EN 1434-6
    - Provide heat meters with integrator, flow sensor, matched pair of temperature sensors and interconnecting cables calibrated as a single unit at manufacturer's works. Installations to be in accordance with manufacturer's recommendations.
    - RHI compliant heat meters and their installation shall meet the requirements of the following:
        - The Renewable Heat Incentive Regulations 2011 as amended.
        - The most recent version of Volume 1 of Ofgem Renewable Heat Incentive Guidance: Eligibility and How to Apply.
        - Annex MI-004 of the EU Measuring Instruments Directive (MID) 2004/22/EC refer to Directive 2014/32/EU from 20th April 2016.

- Commissioning to be carried out by the manufacturer.
- Metering installation arrangement for RHI eligibility
    - Standard metering
- Meter accuracy class for RHI eligibility as defined in Annex MI-004 of the MID/BS EN 1434-1
    - Class 2.
- For RHI installation with a capacity of 45Wth and below the installation shall be undertaken by a Microgeneration Certification Scheme (MCS) certified installer.
- For RHI installation of a capacity of 1MWth and above or when the installation is classed as a multiple metering arrangement, provide an independent report on metering as defined by Ofgem.
- Arrangement
    - In-line.
- Service fluid
    - Water.
- Duty as schedule reference Heat Meters
    - Accuracy class
    - Temperature sampling rate
    - Temperature sensors
        - Installed in pockets.
    - Power
        - External 12V supply.
    - Data option
        - Number of channels
        - Outputs per channel
        - Type
        - Display
    - BMS interface requirements
- Information to be provided for RHI accreditation
    - Manufacturer and models.
    - Design duties.
    - Serial numbers.
    - Evidence of the meter's 'M' and 'CE' marking and approval numbers.
    - Manufacturer's declaration of conformity.

- Confirmation that the maximum and minimum design flow rates/temperatures are within the max/min calibration range of the meter.
- Heat loss assessment questionnaire for external piping in accordance with Ofgem automatic heat loss calculator.

211A.076 ENERGY METERS (FOR PIPELINES):

- Type: provide selection
- Provide energy meters as schedule reference Energy Meters
- Provide heat meters with integrator, sensors and interconnecting cables calibrated as a single unit at the manufacturer's works. Installation to be in accordance with manufacturer's recommendations.
- Commissioning to be carried out by the manufacturer..
- Standard
  - BS EN 1434-6.
- Arrangement
  - In-line.
- Heat transfer fluid
  - Water.
- Temperature sensors
  - Installed in pockets.
- Power
  - External 12V supply.
- Data options
  - Number of channels
  - Outputs per channel
  - Type
  - Display
- BMS interface requirements

211A.080 TEST PLUGS:

- Self sealing test points - reference Y11.2670A
- Valve controlled test points - reference Y11.2670B

211A.100 PIPELINE STRAINERS:

- Bronze (Y type)
  - Screwed to relevant parts of BS EN 10226 - reference Y11.2680A
  - Flanged to BS EN 1092-3 - reference Y11.2680B
  - Compression to BS EN 1254-2
  - Reference Y11.2680C
- Cast iron/ductile iron
  - Y type - flanged to BS EN 1092-2 - reference Y11.2680D

- Flanged suction diffuser type reference Y11.2680G
- Cast iron body with ductile iron cover and cast iron guide vanes (PN16)

    - Ductile iron body and cover, and ductile guide vanes (PN25)

- Ductile iron grooved ends

    - Y type - reference Y11.2680E
    - Suction diffuser strainer - reference Y11.2680F

211A.140 GAUGES:

- General - reference Y11.2700A

    - 150mm black stoved enamel finish

        - Flush panel mounting - reference Y11.2700B
        - Direct mounting - reference Y11.2700C

    - 100mm - finish

- Temperature gauges general - reference Y11.2710A

    - Mercury in steel - reference Y11.2710B
    - Vapour pressure to BS EN 13190

        - Direct mounting - reference Y11.2710C

- Pressure and altitude gauges - reference Y11.2720
- Vacuum gauges - reference Y11.2730
- Differential pressure gauges
- Gauge mounting boards

    - Hardwood - reference Y11.2750A

211A.150 CONTROL VALVES:

- Comply with WRAS requirements.
- CE certified and Kitemark compliant.
- Ball control valves

    - Open/close - reference Y11.2315A
    - Two way - reference Y11.2315B
    - Three way - reference Y11.2315C

211A.160 LOOSE ITEMS:

- Keys for spindle shank valves - reference Y11.3010A
- For drain cocks - reference Y11.3010B

211A.170 CHECK VALVES:

- Comply with WRAS requirements.
- CE certified and Kitemark compliant.

- Service fluid
    - Water.
    -
- Operating temperature (°C)
- PN rating to suite testing pressure.
- Pipe material
    - To suit copper tube.
    - To suit plastic tube.
    - To suit steel tube.
- Copper alloy check type to BS 5154
    - Swing type screwed to relevant parts of BS EN 10226 - reference Y11.2320A
    - Swing type flanged to BS EN 1092-3 - reference Y11.2320B
- Steel and cast iron check valves to BS EN 16767
    - Swing check
        - Flanged - reference Y11.2330A
        - Grooved for mechanical joints.
        - Wafer body - reference Y11.2330B
    - Lift check
        - Flanged - reference Y11.2330C
        - Wafer body - reference Y11.2330D
    - Body material
        - Grey cast iron
        - Malleable cast iron
        - SG cast iron
        - Steel]
- Wafer flange fitting type
    - Reference Y11.2340A
- Steel globe stop and check type to BS EN 13709 - reference Y11.2370#
- Device to prevent contamination of water by backflow to BS EN 14451
    - Combined check and anti-vacuum - reference Y11.2385A
- Anti-back syphonage valve, combined check and anti-vacuum type
    - Reference Y11.2390A
- Anti-back syphonage valve, hose union anti-vacuum type
    - Reference Y11.2391A

211A.175 VERIFIABLE BACKFLOW PREVENTER WITH REDUCED PRESSURE ZONE (RPZ VALVE):

- Comply with WRAS requirements.
- CE certified and Kitemark compliant.

- General requirements - reference Y11.2395A.
- Service fluid
    - Water.
- Operating temperature (°C)
- PN rating to suite testing pressure
- Assembly complete with
    - Isolating valves
    - Strainers
    - Pressure reducing valves
    - Non-return valves
    - Test points
- Tamper free housing or secure cabinet
- Mounting
    - Vertical.
    - Horizontal.
- Installation - reference Y11.2395B.
- On-site inspection and testing - reference Y11.2395C.
- Record of installation and test data - reference Y11.2395D.

211A.180 WORKMANSHIP:

- Installation - reference Y11.4010
- Location - reference Y11.4020
- Location of thermostatic radiator valves - reference Y11.4025
- Positioning of components
    - Flow/pressure measurement valves - reference Y11.4030
    - Double regulating variable orifice valves - reference Y11.4040
    - Install control ball valves in accordance with manufacturer's recommendations.
    - Control components
        - Reference Y11.4050A
- Provide outlets of vent cocks with discharge pipes.
- Valve stuffing boxes - reference Y11.4070
- Discharge connections
    - Safety and Relief valves - reference Y11.4080A
    - Vent cocks - reference Y11.4080B
    - Air bottles - reference Y11.4080C
    - Automatic air vents - reference Y11.4080D
- Expansion devices - reference Y11.4090
- Expansion compensators - reference Y11.4100
- Flexible connections installation - reference Y11.4110
- Terminal unit connections - install hose connections strictly in accordance with manufacturer's instructions.

211A.190 PRESSURE REDUCING AND CONTROL VALVES:

- CE certified and Kitemark compliant.
- Pressure reducing valve
- Pressure control valve - direct acting
- Pressure control valve - with flow regulation

211A.200 DIRECT ACTING SAFETY VALVES:

- Standard
  - BS EN ISO 4126-1 (Safety Valves)
  - BS EN ISO 4126-7 (Common data)
- PN rating to suite testing pressure
- Copper alloy
  - Single spring - reference Y11.2430A
  - Double spring - reference Y11.2430B
- Cast iron

211A.210 DRAIN COCKS:

- Comply with WRAS requirements.
- CE certified and Kitemark compliant.
- Throughway gland cock type
  - Reference Y11.2440A
- Screwdown to BS 2879, type 1 - reference Y11.2450
- Ball type - reference Y11.2460

211A.220 VENT COCKS:

- CE certified and Kitemark compliant.
- PN rating to suite testing pressure
- Two way gland cock type - reference Y11.2470
- Ball type - reference Y11.2480
- Three way gland cock type - reference Y11.2490
- Plug valve type
  - Wrench operated - reference Y11.2500A
  - Gear operated - reference Y11.2500B

211A.230 AUTOMATIC AIR VENTS:

- Float type
  - Reference Y11.2510A

211A.240 DEAERATORS AND SEPARATORS:

- Deaerators
  - Microbubble temperature differential
    - Reference Y11.2515A
  - Pressure differential
    - LTHW - reference Y11.2520A
    - Chilled water - reference Y11.2520B
- Separators
  - Centrifugal air separators
    - Reference Y11.2521A]
  - Gravitation dirt separators
    - Reference Y11.2522A
  - Microbubble air and dirt separators
    - Reference Y11.2524A

211A.260 EXPANSION ARRANGEMENTS/DEVICES AND FLEXIBLE CONNECTIONS:

- PN rating to suite testing pressure
- Provide expansion devices / bellows as schedule reference Expansion Bellows and Flexible Hose Compensators
- Expansion loops
  - Steel
    - Reference Y11.2610A
    - Galvanized after manufacture.
  - Copper - reference Y11.2620
- Expansion compensators
  - Axial bellows
    - Screwed to relevant parts of BS EN 10226 - reference Y11.2630A
    - Flanged to BS EN 1092-1 - reference Y11.2630B
  - Articulated bellows
    - Screwed to relevant parts of BS EN 10226 - reference Y11.2630D
    - Flanged to BS EN 1092-1 - reference Y11.2630E

- Slip-type axial, grooved and expansion compensators
    - Reference Y11.2630J
- Multiple grooved couplings type compensators
    - Reference Y11.2630K

- Flexible connections for noise and vibration attenuation
    - EPDM rubber, up to 100°C
        - Flanged to BS EN 1092-1 - reference Y11.2650A
        - Screwed to relevant parts of BS EN 10226 - reference Y11.2650B
    - Grooved flexible mechanical joints for noise and vibration attenuation
        - Install 3 grooved flexible mechanical joints after the source of vibration and before the first change in pipe direction. Installation to be strictly in accordance with the manufacturer's instructions.
    - Convoluted stainless steel, above 100°C
        - Flanged to BS EN 1092-1 - reference Y11.2650C
    - EPDM rubber, up to 70°C
        - Flanged to BS EN 1092-1 - reference Y11.2650D
        - Screwed to relevant parts BS EN 10226 - reference Y11.2650E
    - Chlorobutyl rubber, up to 100°C
        - Flanged to BS EN 1092-1 - reference Y11.2650F
        - Screwed to relevant parts of BS EN 10226 - reference Y11.2650G
    - Chlorobutyl rubber, up to 60°C
        - Flanged to BS EN 1092-1 - reference Y11.2650H
        - Screwed to relevant parts of BS EN 10226 - reference Y11.2650I
- Terminal unit connections
    - Heating services
        - Stainless steel - reference Y11.2660A
        - Stainless steel with quick release couplings - reference Y11.2660B
        - Rubber - reference Y11.2660C
    - Chilled water services
        - Stainless steel - reference Y11.2660D
        - Stainless steel with quick release couplings - reference Y11.2660E
        - Rubber - reference Y11.2660F

- Flexible hose assemblies for drinking water installations to connect sanitary tap ware, heaters and similar appliances with maximum operating temperature 70°C to be in accordance with BS EN 13618. Flexible hose assemblies intended for use as integral parts of appliances, to be in accordance with BS EN 61770
- Hose and hose assemblies for saturated steam and hot water condensate.

    - Standard - BS EN ISO 6134
    - Type 1 - low pressure, maximum working pressure 6 bar
    - Type 2 - high pressure, maximum working pressure 18 bar
    - Incorporate an oil-resistant cover

Z211B - PIPELINE ANCILLARIES - PLUMBING

211B.010 GENERAL:

- Comply with work section general clauses below
    - Safety and relief valves, self-operated, application - reference Y11.1010
- For applicable valves comply with BS EN 16668 for all essential safety requirements of the Pressure Equipment (Safety) Regulations. Valves excluded from conformance to this standard in the Regulations shall meet "sound engineering practice" by conformity to the relevant product standard.
- Face to face and centre to face dimension of PN and Class designated flanged metal valves to be in accordance with BS EN 558
- Testing of valves
    - Pressure test metallic valves at manufacturer's works, in accordance with BS EN 12266-1 or BS ISO 5208 in conjunction with given specific requirements of the valve product or performance standard.
    - Undertake supplementary tests below in accordance with BS EN 12266-2 in conjunction with given specific requirements of the valve product or performance standard
        - Obturator strength
        - Back seat tightness
        - Operability
        - Anti-static design at 12V
        - Anti-static design at 100V
        - Fire tested design
        - Flow resistance
    - Pressure test thermoplastic valves at manufacturer's works, in accordance with BS ISO 9393-1 in conjunction with given specific requirements of the valve product or performance standard.
- Supply valves as specified in work section

211B.030 STOP VALVES:

- Service fluid
    - Water
- Operating temperature: as designed
- PN to suit system maximum working pressure.
- Comply with WRAS requirements for water services applications.
- Comply with BS EN 1074-1 and BS EN 1074-2 in addition to the particular valve type standard, for valves for water supply applications carrying water for human consumption.
- CE certified and Kitemark compliant.
- Pipe material
    - To suit copper tube.

    - To suit plastic tube.
    - To suit steel tube.

- Copper alloy globe type stop valves (stop cocks) to BS EN 1213 for potable water supplies

    - Compression ends for copper - reference Y11.2015A
    - Compression ends for plastics - reference Y11.2015B
    - Capillary - reference Y11.2015C
    - Threaded - reference Y11.2015D

- Copper alloy gate valves for general use to BS EN 12288

    - Screwed to BS EN ISO 228-1, or ISO 7-1 - reference Y11.2020A
    - Compression to BS EN 1254-2 - reference Y11.2020B
    - Flanged to BS EN 1092-3 - reference Y11.2020C
    - Loose nut/union end - reference Y11.2020D

- Cast iron gate valves for general use to BS EN 1171

    - Grey cast iron flanged to BS EN 1092-2 - reference Y11.2030A

- Copper alloy globe valves for general use to BS 5154 and BS EN 12288

    - Screwed to relevant parts of BS EN 10226 - reference Y11.2040A
    - Flanged to BS EN 1092-3 - reference Y11.2040B
    - Compression to BS EN 1254-2 - reference Y11.2040C
    - Compression to BS EN 1254-3 - reference Y11.2040D

- Cast iron globe valves for general use to BS EN 13789

    - Grey cast iron flanged to BS EN 1092-2 - reference Y11.2050A

- Steel wedge type gate valve for general use to BS EN 1984

    - Flanged to BS EN 1092-1 - reference Y11.2070A
    - Threaded - reference Y11.2070D
    - Auxiliary connections

- Ball valves

    - Application, standard and material

        - Potable water - copper alloy to BS EN 13828, PN 10 and distribution temperature of 65 °C with occasional excursions up to 90 °C permitted for a period of 1 hour maximum.

    - Screw driver/key operated

        - Screwed to relevant parts of BS EN 10226 - reference Y11.2080A
        - Compression to BS EN 1254-2 - reference Y11.2080B

    - Lever operated

        - Screwed to relevant parts of BS EN 10226 - reference Y11.2080C
        - Compression to BS EN 1254-2 - reference Y11.2080D

    - Lockshield

        - Screwed to relevant parts of BS EN 10226 - reference Y11.2080E
        - Compression to BS EN 1254-2 - reference Y11.2080F

- Servicing valves, for water services for maintenance of fittings / appliances, copper alloy to BS 6675

    - Handwheel operated

        - Screwed ends - reference Y11.2085A
        - Compression ends - reference Y11.2085B
        - Capillary ends - reference Y11.2085C

    - Lever operated

        - Screwed ends - reference Y11.2085D
        - Compression ends - reference Y11.2085E
        - Capillary ends - reference Y11.2085F

    - Screw driver operated

        - Screwed ends - reference Y11.2085G
        - Compression ends - reference Y11.2085H

    - Capillary ends - reference Y11.2085I

- Butterfly valves for general use to BS EN 593

    - Semi-lugged between flanges to BS EN 1092-2

        - Lever operated - reference Y11.2090A
        - Gear operated - reference Y11.2090B

    - Between mechanical joints

        - Lever operated - reference Y11.2090C
        - Gear operated - reference Y11.2090D

    - Fully-lugged to BS EN 593 - reference Y11.2090E

        - Lever operated.
        - Gear operated.

- Cast iron gate type for waterworks purposes to relevant parts of BS 5163
- Key operated type A - reference Y11.2110A

211B.040 REGULATING VALVES:

- Service fluid
    - Water
- Operating temperature: as designed
- PN to suit system maximum working pressure.
- Comply with WRAS requirements.
- CE certified and Kitemark compliant.
- Pipe material
    - To suit copper tube.
    - To suit plastic tube.
    - To suit steel tube.

211B.050 DOUBLE REGULATING VALVES:

- Service fluid
    - Water
- PN to suit system maximum working pressure.
- Comply with WRAS requirements.
- CE certified and Kitemark compliant.
- Pipe material
    - To suit copper tube.
    - To suit plastic tube.
    - To suit steel tube.
- Butterfly type to BS EN 593
    - Between flanges to BS EN 1092-2
        - Lever operated - reference Y11.2210A
        - Gear operated - reference Y11.2210B
    - Between mechanical joints
        - Lever operated - reference Y11.2210C
        - Gear operated - reference Y11.2210D
- Globe valves to BS 7350, section 3.1.
    - Copper alloy
        - Screwed to relevant parts of BS EN 10226 - reference Y11.2220A
        - Flanged to BS EN 1092-2 - reference Y11.2220B

- Cast iron
    - Flanged to BS EN 1092-2 - reference Y11.2220C

211B.060 FLOW MEASUREMENT VALVES:

- Service fluid
    - Water
- Operating temperature: as designed
- PN to suit system maximum working pressure.
- Provide expansion devices / bellows as schedule reference Expansion Bellows and Flexible Hose Compensators
- Comply with WRAS requirements.
- CE certified and Kitemark compliant.
- Pipe material
    - To suit copper tube.
    - To suit plastic tube.
    - To suit steel tube.
- Flow measurement devices to BS 7350
    - Section 3.2 Type 3
        - Copper alloy
            - Screwed to relevant parts of BS EN 10226 - reference Y11.2230A
            - Flanged to BS EN 1092-3 - reference Y11.2230B
        - Cast iron
            - Flanged to BS EN 1092-2 - reference Y11.2230C
    - Section 3.2 Type 4
        - Copper alloy
            - Screwed to relevant parts of BS EN 10226 - reference Y11.2230E
            - Flanged to BS EN 1092-3 - reference Y11.2230F
        - Cast iron - reference Y11.2230G
- Variable orifice valve
- Fixed orifice valve

211B.070 FLOW REGULATORS AND COMBINATION VALVES:

- Service fluid
    - Water

- Operating temperature: as designed
- PN to suit system maximum working pressure.
- Comply with WRAS requirements.
- CE certified and Kitemark compliant.
- Pipe material

    - To suit copper tube.
    - To suit plastic tube.
    - To suit steel tube.

211B.080 TEST PLUGS:

- Self sealing test points - reference Y11.2670A
- Valve controlled test points - reference Y11.2670B

211B.100 PIPELINE STRAINERS:

- Bronze (Y type)

    - Screwed to relevant parts of BS EN 10226 - reference Y11.2680A
    - Flanged to BS EN 1092-3 - reference Y11.2680B
    - Compression to BS EN 1254-2
    - Reference Y11.2680C

- Cast iron/ductile iron

    - Y type - flanged to BS EN 1092-2 - reference Y11.2680D
    - Flanged suction diffuser type reference Y11.2680G
    - Cast iron body with ductile iron cover and cast iron guide vanes (PN16)

        - Ductile iron body and cover, and ductile guide vanes (PN25)

- Ductile iron grooved ends

    - Y type - reference Y11.2680E
    - Suction diffuser strainer - reference Y11.2680F

211B.120 TUNDISHES:

- Copper - reference Y11.2690A
- Mild steel, galvanized - reference Y11.2690B

211B.130 FLOAT OPERATED VALVES:

- Service fluid

    - Water

- Operating temperature: as designed

- PN to suit system maximum working pressure.
- Comply with WRAS requirements.
- CE certified and Kitemark compliant.
- WRc approved.
- To BS 1212
    - Piston type 1
        - Copper float - reference Y11.2280A
        - Plastic float - reference Y11.2280B
    - Float BS reference
        - Spherical
        - Grade C Float.
        - Grade H Float.
- Balanced equilibrium type
    - Screwed inlet to relevant parts of BS EN 10226 - reference Y11.2290A

211B.140 GAUGES:

- General - reference Y11.2700A
    - 150mm black stoved enamel finish
        - Flush panel mounting - reference Y11.2700B
        - Direct mounting - reference Y11.2700C
    - 100mm - finish
- Temperature gauges general - reference Y11.2710A
    - Mercury in steel - reference Y11.2710B
    - Vapour pressure to BS EN 13190
        - Direct mounting - reference Y11.2710C
- Pressure and altitude gauges - reference Y11.2720
- Vacuum gauges - reference Y11.2730
- Differential pressure gauges
- Gauge mounting boards
    - Hardwood - reference Y11.2750A

211B.150 CONTROL VALVES:

- Comply with WRAS requirements.
- CE certified and Kitemark compliant.

- Ball control valves
    - Open/close - reference Y11.2315A
    - Two way - reference Y11.2315B
    - Three way - reference Y11.2315C

211B.155 WATER-HAMMER ARRESTERS (WATER SHOCK ABSORBER)

- Type
    - Metal bellows]
    - Copper tube with piston
- Comply with WRAS requirements.
- CE certified.
- Factory precharged
- Connection
    - Threaded
- Shell
    - Stainless steel
- Body
    - Stainless steel

211B.160 LOOSE ITEMS:

- Keys for spindle shank valves - reference Y11.3010A
- For drain cocks - reference Y11.3010B

211B.170 CHECK VALVES:

- Comply with WRAS requirements.
- CE certified and Kitemark compliant.
- Service fluid
    - Water.
- Operating temperature: as designed
- PN to suit system maximum working pressure.
- Pipe material
    - To suit copper tube.
    - To suit plastic tube.
    - To suit steel tube.
- Copper alloy check type to BS 5154

- Swing type screwed to relevant parts of BS EN 10226 - reference Y11.2320A
- Swing type flanged to BS EN 1092-3 - reference Y11.2320B

- Steel and cast iron check valves to BS EN 16767
  - Swing check
    - Flanged - reference Y11.2330A
    - Grooved for mechanical joints.
    - Wafer body - reference Y11.2330B
  - Lift check
    - Flanged - reference Y11.2330C
    - Wafer body - reference Y11.2330
  - Body material
    - Grey cast iron]
    - Malleable cast iro
    - SG cast iron
    - Steel
- Wafer flange fitting type
  - Reference Y11.2340A
- Steel globe stop and check type to BS EN 13709 - reference Y11.2370#
- Device to prevent contamination of water by backflow to BS EN 14451
  - Combined check and anti-vacuum - reference Y11.2385A
- Anti-back syphonage valve, combined check and anti-vacuum type
  - Reference Y11.2390A
- Anti-back syphonage valve, hose union anti-vacuum type
  - Reference Y11.2391A

211B.175 VERIFIABLE BACKFLOW PREVENTER WITH REDUCED PRESSURE ZONE (RPZ VALVE):

- Comply with WRAS requirements.
- CE certified and Kitemark compliant.
- General requirements - reference Y11.2395A.
- Service fluid
  - Water.
- Operating temperature: as designed.
- PN to suit system maximum working pressure.
- Assembly complete with

        - Isolating valves
        - Strainer
        - Pressure reducing valves
        - Non-return valves
        - Test points

    - Tamper free housing or secure cabinet
    - Mounting

        - Vertical.
        - Horizontal.

    - Installation - reference Y11.2395B.
    - On-site inspection and testing - reference Y11.2395C.
    - Record of installation and test data - reference Y11.2395D.

211B.180 WORKMANSHIP:

    - Installation - reference Y11.4010
    - Location - reference Y11.4020
    - Location of thermostatic radiator valves - reference Y11.4025
    - Positioning of components

        - Flow/pressure measurement valves - reference Y11.4030
        - Double regulating variable orifice valves - reference Y11.4040
        - Install control ball valves in accordance with manufacturer's recommendations.
        - Control components

            - Reference Y11.4050A

    - Provide outlets of vent cocks with discharge pipes.
    - Valve stuffing boxes - reference Y11.4070
    - Discharge connections

        - Safety and Relief valves - reference Y11.4080
        - Vent cocks - reference Y11.4080B
        - Air bottles - reference Y11.4080C
        - Automatic air vents - reference Y11.4080D

    - Expansion devices - reference Y11.4090
    - Expansion compensators - reference Y11.4100
    - Flexible connections installation - reference Y11.4110
    - Terminal unit connections - install hose connections strictly in accordance with manufacturer's instructions.

211B.190 PRESSURE REDUCING AND CONTROL VALVES:

    - CE certified and Kitemark compliant.
    - Pressure reducing valve
    - Pressure control valve - direct acting
    - Pressure control valve - with flow regulation

211B.200 DIRECT ACTING SAFETY VALVES:

- Standard
    - BS EN ISO 4126-1 (Safety Valves)
    - BS EN ISO 4126-7 (Common data)
- PN to suit system maximum working pressure.
- Copper alloy
    - Single spring - reference Y11.2430A
    - Double spring - reference Y11.2430B
- Cast iron

211B.210 DRAIN COCKS:

- Comply with WRAS requirements.
- CE certified and Kitemark compliant.
- Throughway gland cock type
    - Reference Y11.2440A
- Screwdown to BS 2879, type 1 - reference Y11.2450
- Ball type - reference Y11.2460

211B.220 VENT COCKS:

- CE certified and Kitemark compliant.
- PN to suit system maximum working pressure.
- Two way gland cock type - reference Y11.2470
- Ball type - reference Y11.2480
- Three way gland cock type - reference Y11.2490
- Plug valve type
    - Wrench operated - reference Y11.2500A
    - Gear operated - reference Y11.2500B

211B.230 AUTOMATIC AIR VENTS:

- Float type
    - Reference Y11.2510A

211B.260 EXPANSION ARRANGEMENTS/DEVICES AND FLEXIBLE CONNECTIONS:

- PN to suit system maximum working pressure.
- Provide expansion devices / bellows as schedule reference Expansion Bellows and Flexible Hose Compensators
- Expansion loops
    - Steel
        - Reference Y11.2610A
        - Galvanized after manufacture.
    - Copper - reference Y11.2620
- Expansion compensators
    - Axial bellows
        - Screwed to relevant parts of BS EN 10226 - reference Y11.2630A
        - Flanged to BS EN 1092-1 - reference Y11.2630B
    - Articulated bellows
        - Screwed to relevant parts of BS EN 10226 - reference Y11.2630D
        - Flanged to BS EN 1092-1 - reference Y11.2630E
    - Slip-type axial, grooved and expansion compensators
        - Reference Y11.2630J
    - Multiple grooved couplings type compensators
        - Reference Y11.2630K
- Flexible connections for noise and vibration attenuation
    - EPDM rubber, up to 100°C
        - Flanged to BS EN 1092-1 - reference Y11.2650A
        - Screwed to relevant parts of BS EN 10226 - reference Y11.2650B
    - Grooved flexible mechanical joints for noise and vibration attenuation
        - Install 3 grooved flexible mechanical joints after the source of vibration and before the first change in pipe direction. Installation to be strictly in accordance with the manufacturer's instructions.
    - Convoluted stainless steel, above 100°C
        - Flanged to BS EN 1092-1 - reference Y11.2650C

- EPDM rubber, up to 70°C

    - Flanged to BS EN 1092-1 - reference Y11.2650D
    - Screwed to relevant parts BS EN 10226 - reference Y11.2650E

- Chlorobutyl rubber, up to 100°C

    - Flanged to BS EN 1092-1 - reference Y11.2650F
    - Screwed to relevant parts of BS EN 10226 - reference Y11.2650G

- Chlorobutyl rubber, up to 60°C

    - Flanged to BS EN 1092-1 - reference Y11.2650H
    - Screwed to relevant parts of BS EN 10226 - reference Y11.2650I

SECTION Z220a - PUMPS - HYDRONICS

220A.010 GENERAL:

- Comply with general clauses below
    - Pumps generally - reference Y20.1010
    - Pump selection for efficiency/EC ecodesign requirements - reference Y20.1020
    - Safety guards - reference Y20.1030
    - Pump testing - reference Y20.1040
- Ensure all electrical equipment supplied and installed is suitable for power supply indicated.
- Provide details of electrical input, starting and performance characteristics of all motors above 750W to an agreed format.
- Where appropriate ensure motors and drives are supplied complete with keys and keyways.
- Spare parts
    - Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
        - Mechanical Seals: One set of mechanical seals for each pump.
- Design duties
    - Ensure scheduled volume is provided when operating against resistance of system corrected for changes between specified and selected component resistances.
- Comply with section Y92A for specifications of starters and VSD

220A.030 PUMP AND MOTOR:

- Type:
    - Centrifugal, Close coupled direct drive end suction. Reference Y20.2010C
    - Centrifugal, Split Case. Reference Y20.2010F
    - Centrifugal pumps. Comply with BS EN ISO 9908.
    - Connections
        - Flanged to BS EN 1092-1 PN for Steel flanges
    - Motor
        - Motor operating conditions
            - Standard operating conditions - reference Y92.2010A
        - Surge suppressors
            - Manufacturer fitted - reference Y92.1040#
        - Motor type
            - Asynchronous induction with VSD.
        - Standards - reference Y92.1010

- General - reference Y92.2020

  - Provide protected enclosures against external mechanical impacts in accordance with BS EN 62262

    - IK08.

- Motor efficiency

    - For VSD motors: Efficiency class IE2, reference Y92.2025A;

- Degree of protection in accordance with BS EN 60034-5

  - IP55.

- Method of motor cooling in accordance with BS EN 60034-6, reference Y92.2020
- Motors - over temperature protection

  - Thermistors - reference Y92.2060A

- Guards -Reference Y92.2090A
- Accessories

  - Casing thermal insulation.
  - Matching flanges PN

220A.060 WORKMANSHIP:

- General - reference Y20.4010
- Pipeline connections - reference Y20.4020
- Alignment - reference Y20.4040
- Access - reference Y20.4050

SECTION **Z220B - PUMPS - PLUMBING**

220B.010 GENERAL:

- Comply with general clauses below
    - Pumps generally - reference Y20.1010
    - Pump selection for efficiency/EC ecodesign requirements - reference Y20.1020
    - Safety guards - reference Y20.1030
    - Pump testing - reference Y20.1040
- Ensure all electrical equipment supplied and installed is suitable for power supply indicated.
- Provide details of electrical input, starting and performance characteristics of all motors above 750W to an agreed format.
- Where appropriate ensure motors and drives are supplied complete with keys and keyways.
- Design duties
    - Ensure scheduled volume is provided when operating against resistance of system corrected for changes between specified and selected component resistances.
- Comply with section Y92A for specifications of starters and VSD

220B.030 PUMP AND MOTOR:

- Type:
    - Centrifugal, Close coupled direct drive end suction. Reference Y20.2010C
    - Centrifugal, Direct drive in-line, Vertical pump. Reference Y20.2010D
    - Centrifugal, Direct drive, glandless circulator. Reference Y20.2010E
    - Centrifugal, Split Case. Reference Y20.2010F
- Maximum temperature of fluid: as designed
- Centrifugal pumps. Comply with BS EN ISO 9908.
- Connections
    - Flanged to BS EN 1092-1 PN for Steel flanges
    - Flanged to BS EN 1092-2 PN for Cast iron flanges
    - Screwed to relevant parts of BS EN 10226
- Motor
    - Motor operating conditions
        - Standard operating conditions - reference Y92.2010A
    - Surge suppressors
        - Manufacturer fitted - reference Y92.1040#
    - Motor type
        - Induction (asynchronous).

        - Asynchronous induction with VSD.
        - Permanent-Magnet Synchronous with VSD.
        - Magnet free synchronous reluctance with VSD.
        - EC Permanent-Magnet Synchronous with integral AC to DC converter (rectifier) and electronic controls with 0-10V control input.
        - EC Permanent-Magnet Synchronous with integral AC to DC converter (rectifier) and electronic controls with 0-10V control input and integral PID controller to enable sensors to be connected directly to the motor.

    - Standards - reference Y92.1010
    - General - reference Y92.2020

        - Provide protected enclosures against external mechanical impacts in accordance with BS EN 62262

            - IK08.

    - Motor efficiency

        - For VSD motors: Efficiency class IE2, reference Y92.2025A;
        - For constant speed motors: Efficiency class IE3, reference Y92.20205B

    - Degree of protection in accordance with BS EN 60034-5

        - IP55.

    - Method of motor cooling in accordance with BS EN 60034-6, reference Y92.2020
    - Motors - over temperature protection

        - Thermistors - reference Y92.2060A

- Guards -Reference Y92.2090A
- Accessories

    - Casing thermal insulation.

220B.040 PACKAGED WATER BOOSTER SETS:

- Pressure booster set(s) to be complete with pump(s), control vessel (hydraulic accumulator), suction and discharge manifolds, control transducer, pre-wired control panel and interconnecting pipework assembled on a fabricated skid, and tested in pumps manufacturer own facility.
- Booster set to be compliant with WRAS requirements.
- Type

    - [Multiple pumps with break tank.]

- Pumping arrangement

    - Variable speed pumps.

- Base frame skid

- Stainless steel.

- Pumps/motors
    - Number of duty pumps to achieve design total flow rate and pressure
    - Number of standby pumps: as designed
    - Pump type
        - Stainless steel multistage centrifugal.
        - Stainless steel end suction, single impeller self-priming.
    - Motor type
        - Permanent magnet super premium efficiency.
        - TEFV AC asynchronous induction high efficiency.
    - Motor efficiency to BS EN 60034-30-1 (IE)
    - Pump starting method
        - Frequency converter/inverter built into motor.

- Hydraulic accumulator
    - Diaphragm material to be WRAS approved in accordance with relevant parts of BS 6920 and BS EN 15768

- Pipework manifolds
    - Connections
        - Screwed
        - Flanged
    - Material
        - 304 stainless steel

- Valves and fittings
    - Provide isolation valves on suction and discharge side of pumps.
    - Provide non-return valves on discharge side of each pump.
    - Provide pressure gauge in discharge manifold.
    - Isolation valve type
        - Ball Valve.
        - Butterfly.

- Controls
    - Pump operation
        - Constant pressure control by pump switching.
        - Constant pressure control by pump seed control.

        - Multiple pump cascade operation by pressure transducer in discharge flow manifold.

    - Alarms and indication
    - Audiable alarm is not required when there is a BMS interface for the Pumps.

        - For interface points to the BMS, refer to BMS control diagrams and specs.
        - Pump run and trip for each pump.
        - Low water cut off.

    - Control panel

        - Factory installed and connected as an integral part of unit.
        - Panel IP rating IP54

    - BMS interface requirements

- Accessories

    - Additional control module to provide surge protection on start-up or when power is restored by allowing only one pump to be enabled and pulsed for a pre-set time until a pre-set pressure is reached.
    - Combined anti-vacuum, automatic air vent and surge protection valve supplied loose for fitting at top of risers
    - Flexible connections
    - Anti-vibration mountings

220B.060 WORKMANSHIP:

- General - reference Y20.4010
- Pipeline connections - reference Y20.4020
- Alignment - reference Y20.4040
- Access - reference Y20.4050
- Maintenance requirements for sewage pumps

    - Reference Y20.4060

- Install pressurisation equipment and pressure booster sets in accordance with manufacturer's recommendations.
- Install test and commission systems to comply with equipment manufacturer's recommendations, BS EN 806-4

SECTION Z220c - PUMPS - FIREFIGHTING

Z220C.010 SYSTEM PERFORMANCE REQUIREMENTS

- Fire-Pump Systems: Fire-pump and pressure-maintenance-pump units that comply with performance requirements specified and are compatible with building fire-suppression systems.

- Pump, Equipment, Accessory, and Piping Pressure Rating: 1200-kPa (175-psig) minimum working-pressure rating, unless higher rating is indicated.

Z220C.020 QUALITY ASSURANCE

- Manufacturer Qualifications: Firms whose fire pumps, pressure-maintenance pumps, drivers, controllers, and accessories are listed by product name and manufacturer in UL's "Fire Protection Equipment Directory" and FM's "Fire Protection Approval Guide" and that comply with requirements indicated.

- Source Limitations: Obtain fire-pump and pressure-maintenance-pump units through one source with responsibility and accountability to respond to and resolve problems regarding compatibility, installation, performance, and acceptance of units.

- Product Options: Drawings indicate size, profiles, connections, and dimensional requirements of fire-pump and pressure-maintenance-pump units and are based on specific models selected. Other manufacturers' pump units with equal performance characteristics may be considered. Refer to Division 1 Section "Product Requirements."

- Provide listing/approval stamp, label, or other marking on equipment made to specified standards.

- Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to Engineer.

- Comply with standards of authorities having jurisdiction pertaining to materials, hose threads, and installation.

- Comply with NFPA 20, "Installation of Stationary Pumps for Fire Protection," for fire pumps, drivers, controllers, accessories, and installation.

Z220C.030 SPLIT-CASE FIRE PUMPS

- Multistage, Horizontally Mounted, Split-Case Fire Pumps: UL 448, factory-assembled and –tested as a one package in country of origin (UL listed & FM approved), electric-drive, two-stage, single-suction, horizontal type. Include pump, driver, controller, etc… mounted on same base and connected with coupling.

    - Characteristics: Capable of furnishing not less than 150 percent of rated capacity at not less than 65 percent of total rated head. Shutoff head is limited to 140 percent of total rated head.
    - Casing: Axially split cast iron with suction and discharge flanges machined to ASME B16.1, Class 125 dimensions, unless Class 250 flanges are indicated.
    - Impeller: Cast bronze of construction to match fire pump, statically and dynamically balanced, and keyed to shaft.

- Wear Rings: Replaceable, bronze.
- Shaft and Sleeve: Stainless Steel shaft with bronze sleeve.
- Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
- Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
- Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
- Driver: Electric motor.
- Finish: Manufacturer's standard red paint applied to factory-assembled and -tested unit before shipping.
- Nameplate: Complete with capacities, characteristics, and other pertinent data.
- Base: Fabricated and attached to fire-pump and driver unit with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.

Z220C.040 PUMP DRIVERS

- Description: UL 1004A, NEMA MG 1, totally enclosed, fan cooled, squirrel-cage, induction motor. Motor shall comply with Division 21 Section “Common Motor Requirements for Fire Suppression Equipment”. Include construction complying with NFPA 20 and NFPA 70, and include wiring compatible with controller used.

  - Finish: Manufacturer's standard red paint applied to factory-assembled and -tested unit before shipping.
  - Nameplate: Complete with motor horsepower, characteristics, and other pertinent data.

Z220C.050 PUMP CONTROLLERS, GENERAL

- Description: Combined automatic and nonautomatic operation; factory assembled and wired; factory tested for capacities and electrical characteristics; and with the following features:

  - Enclosure: UL 50, Type 12, water proof, indoor, unless special-purpose enclosure is indicated.
  - Controls, devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used, and specific items listed for each controller type.
  - Nameplate: Complete with capacity, characteristics, approvals and listings, and other pertinent data.
  - Controller Sensing Pipes: Fabricate pipe and fittings according to NFPA 20 with nonferrous-metal sensing piping, DN15 (NPS 1/2), with globe valves for testing controller mechanism from system to pump controller as indicated. Include bronze check valve with 2.4-mm orifice in clapper or ground-face union with noncorrosive diaphragm having 2.4-mm orifice.

Z220C.055 DIESEL ENGINE PUMP DRIVERS

- Fire-Pump Drivers: UL 1247, horizontal-shaft, open-type diesel engine. Include the following:

  - Finish: Manufacturer's standard red paint applied to factory-assembled and -tested unit before shipping.
  - Nameplate: Complete with engine horsepower, characteristics, and other pertinent data.
  - Emergency Manual Operator: Factory wired for standby engine starting and operation in case of main controller or wiring malfunction.

- Engine Cooling System: Factory-installed water piping, valves, strainer, pressure regulator, heat exchanger, coolant pump, bypass piping, and fittings. Include ASTM B 88M, Type B (ASTM B 88, Type L), copper water tube; ASME B16.22, wrought-copper, solder-joint pressure fittings; AWS A5.8/A5.8M, BCuP Series brazing filler metal; and brazed joints.
- Exhaust Connector: Flexible type.
- Exhaust Silencer: Residential type.
- Engine-Jacket Water Heater: Factory-installed electric elements.
- Dual Batteries: Lead-acid-storage type, with 100 percent standby reserve capacity.
- Fuel System: According to NFPA 20.
- Fuel Storage Tank: Size indicated, but not less than required by NFPA 20. Include floor legs, direct-reading level gage, and secondary containment tank with capacity at least equal to fuel storage tank.
- Exhaust System: ASTM A 53/A 53M, Type E or S, Schedule 40, black steel pipe; ASME B16.9, weld-type pipe fittings; ASME B16.5, steel flanges; and ASME B16.21, nonmetallic gaskets. Fabricate double-wall, ventilated thimble from steel pipe.

Z220C.058 MULTISTAGE, PRESSURE-MAINTENANCE PUMPS

- Description: Factory-assembled and -tested, multistage, barrel-type vertical pump as defined in HI 2.1-2.2 and HI 2.3; designed for surface installation with pump and motor direct coupled and mounted vertically.

- Pump Construction:

  - Barrel: Stainless steel.
  - Suction and Discharge Chamber: Cast iron with flanged inlet and outlet.
  - Pump Head/Motor Mount: Cast iron.
  - Impellers: Stainless steel, balanced, and keyed to shaft.
  - Pump Shaft: Stainless steel.
  - Seal: Mechanical type with carbon rotating face and silicon-carbide stationary seat.
  - Intermediate Chamber Bearings: Aluminum-oxide ceramic or bronze.
  - Chamber-Base Bearing: Tungsten carbide.
  - O-Rings: EPDM or NBR.

- Motor: Single speed with permanently lubricated ball bearings and rigidly mounted to pump head.

  - Power Cord: Factory-connected to motor for field connection to controller and at least 10 feet (3 m) long.

- Nameplate: Permanently attached to pump and indicating capacity and characteristics.

- Capacities and Characteristics, as per design requirements:
  - Working Pressure: 175-psig (1200 kPa) minimum.

Z220C.060 FIRE-PUMP CONTROLLERS

- Description: UL 218 and NFPA 20; listed for electric-drive, fire-pump service.

- Motor Starting: Reduced-voltage soft starter or auto transformer type as per manufacturer's recommendation and Engineer's approval, unless otherwise specified or shown on the Drawings.

- Fire pump controller shall be provided with surge arresters in compliance with IEEE C62.1 or IEEE C62.11 and shall be installed in common mode to eliminate overvoltage between each phase and earth. As an alternative, the controller shall withstand without any damage 10 kV impulse in accordance with IEEE C62.41 or ANSI/UL 1449.

- Method of Control:

    - Pressure-switch actuated.

        - Water-pressure-actuated switch and pressure transducer with independent high- and low-calibrated adjustments responsive to water pressure in fire-suppression piping.
        - System pressure recorder, electric ac driven, with spring backup.
    - Emergency Start: Mechanically operated start handle that closes and retains the motor RUN contactor independent of all electric or pressure actuators.

- Method of Stopping: Nonautomatic.

- Rate controllers for scheduled horsepower. Include short-circuit withstand rating at least equal to short-circuit current available at controller location. Take into account cable size and distance from substation or supply transformers.

- Method of Isolation and Overcurrent Protection: Interlocked isolating switch and MCCB (Molded-case circuit breaker); with a common, externally mounted operating handle, and providing locked-rotor protection. Fire pump controller circuit breaker settings shall comply with NFPA 20 requirements. The circuit breaker shall not trip when starting a motor from rest in the across-the-line mode, whether or not the controller is of the reduced inrush starting type.

- Door-Mounted Operator Interface and Controls:

    - Monitor, display, and control the devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
    - Method of Control and Indication:

        - Microprocessor-based logic controller, with multiline digital readout.
        - Membrane keypad.
        - LED alarm and status indicating lights.

    - Local and Remote Alarm and Status Indications for Electric Driven Pump:

        - Controller power on.
        - Motor running condition.
        - Loss-of-line power.
        - Line-power phase reversal.
        - Line-power single-phase condition.

    - Local and Remote Alarm and Status Indications for Diesel Engine Pump:

        - Controller power on.
        - Engine-lubrication-system critically low oil pressure.
        - Engine-jacket coolant high temperature.
        - Engine fail-to-start.
        - Engine overspeed shutdown.
        - Low fuel level.
        - Missing or failed battery.
        - Battery charger failure.
        - System overpressure.

        - ECM selector switch in alternate ECM position.
        - Fuel injector malfunction.

    - Audible alarm, with silence push button.
    - Nonautomatic START and STOP push buttons or switches.

- Optional Features:

    - Extra Output Contacts:

        - One N.O. contact(s) for motor running condition.
        - One set(s) of contacts for loss-of-line power.
        - One each, Form C contacts for high and low reservoir level.

    - Local alarm bell.
    - Door-mounted thermal or impact printer for alarm and status logs.
    - Operator Interface Communications Ports: USB, Ethernet, and RS485.

- Automatic Transfer Switches:

    - Complies with NFPA 20, UL 218, UL 1008 and FM approved.
    - Integral with controller as a listed combination fire-pump controller and power transfer switch and shall be housed in a barriered compartment of the fire pump controller or in a separate enclosure attached to the controller and marked “Fire Pump Power Transfer Switch”.
    - Automatically transfers fire-pump controller from normal power supply to alternate power supply in event of power failure and retransfers to normal power supply upon return of power supply with a time delay till the normal source is stabilized, unless the alternate source fails.
    - Electrically operated and mechanically held.
    - Allows manual transfer from one source to the other.
    - Local and Remote Alarm and Status Indications:

        - Normal source available.
        - Alternate source available.
        - In normal position.
        - In alternate position.
        - Isolating means open.

    - Audible alarm, with silence push button.
    - Nonautomatic (manual, nonelectric) means of transfer.
    - Engine test push button.
    - Start generator output contacts.
    - Timer for weekly generator tests.

Z220C.065 CONTROLLERS FOR PRESSURE-MAINTENANCE PUMPS

- General Requirements for Pressure-Maintenance-Pump Controllers:

    - Type: UL 508 factory assembled, -wired, and tested, across-the-line; for combined automatic and manual operation.
    - Enclosure: UL 508 and NEMA 250, Type 12 for wall-mounting.
    - Factory assembled, wired, and tested.
    - Finish: Manufacturer's standard color paint.

- Rate controller for scheduled horsepower and include the following:

    - Fusible disconnect switch.
    - Pressure switch.
    - Hand-off-auto selector switch.
    - Pilot light.
    - Running period timer.

Z220C.070 FIRE-PUMP SPECIALTIES AND ACCESSORIES

- Match fire-pump suction and discharge ratings as required for fire-pump capacity rating, and complying with NFPA-20 requirements. Include the following:

    - Automatic air-release valve, complying with NFPA 20 for installation in fire-pump casing.
    - Circulation relief valve, UL 1478, brass, spring loaded; for installation in pump discharge piping.
    - Relief valves, UL 1478, bronze or cast iron, spring loaded; for installation in fire-suppression water-supply piping.
    - Suction and discharge pressure gages.
    - Eccentric-tapered reducer at suction inlet.
    - Concentric-tapered reducer at discharge outlet.
    - Discharge Cone: Closed or open type.

    - Hose Valve Manifold Assembly:

        a. Standard: Comply with requirements in NFPA 20.
        b. Header Pipe: ASTM A 53/A 53M, Schedule 40, galvanized steel with ends threaded according to ASME B1.20.1.
        c. Header Pipe Fittings: ASME B16.4, galvanized cast-iron threaded fittings.
        d. Automatic Drain Valve: UL 1726.
        e. Manifold:
            - Test Connections: Comply with UL 405 except provide outlets without clappers instead of inlets.
            - Body: Flush type, brass or ductile iron, with number of outlets required by NFPA 20.
            - Nipples: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with ends threaded according to ASME B1.20.1.
            - Adapters and Caps with Chain: Brass or bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
            - Escutcheon Plate: Brass or bronze; rectangular.
            - Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
            - Exposed Parts Finish: Polished or brass.
            - Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

Z220C.075 PRESSURE-MAINTENANCE-PUMP SPECIALTIES AND ACCESSORIES

- Match pressure-maintenance-pump suction and discharge ratings as required for pump capacity rating. Include the following:

    - Circulation relief valve.
    - Suction and discharge pressure gages.

Z220C.080 ALARM PANELS

- Description: Factory-assembled and -wired remote panel complying with UL 508 and requirements in NFPA 20. Include audible and visible alarms matching controller type.
    - Enclosure: NEMA 250, Type 2, remote wall-mounting type.
    - Enclosure Finish: Manufacturer's standard red paint applied to factory-assembled and -tested unit before shipping.
- Features for electric driven pump: Include manufacturer's standard features and the following:
    - Motor-operating condition.
    - Loss-of-line power.
    - Phase reversal.
    - Low-water alarm.
- Features for diesel engine driven pump: Include manufacturer's standard features and the following:
    - Engine running.
    - Main switch off or in manual position.
    - Engine trouble.
    - Low-water alarm.
    - Low fuel.

Z220C.090 FLOW-MEASURING SYSTEMS

- Description: UL-listed or FM-approved, fire-pump, flow-measuring systems that indicate flow to not less than 175 percent of fire-pump rated capacity. Include sensor of size to match pipe, tubing, flow meter, and fittings.
    - Pressure Rating: 1200 kPa (175 psig)) minimum.
    - Sensor: Venturi, annular probe, or orifice plate, unless otherwise indicated. Sensor size shall match pipe, tubing, flow meter, and fittings.
    - Flow Meter: Compatible with flow sensor with dial not less than 115 mm in diameter or manufacturer's equivalent size.
    - Permanently Mounted: Flow meter suitable for wall mounting with copper tubing to connect to flow sensor.
    - Include complete operating instructions.

Z220C.100 SOURCE QUALITY CONTROL

- Factory Tests: Hydrostatically test and test run fire pumps before shipping according to UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests." Test at 150 percent of shutoff head plus suction head, but not less than 1725 kPa (250 psig). Produce certified test curves and inspection reports showing head capacity and brake horsepower of each pump.
- Fire pumps will be considered defective if they do not pass tests and inspections.

Z220C.110 GROUT

- Description: ASTM C 1107/C 1107M, Grade B, factory-mixed and -packaged nonshrink and nonmetallic grout; suitable for interior and exterior applications.
- Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout.
- Properties: Nonstaining, noncorrosive, and nongaseous.
- Design Mix: 34.5-MPa, 28-day compressive strength.

Z220C.120 EXAMINATION

- Examine areas, equipment foundations, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting fire-pump performance.
    - Proceed with installation only after unsatisfactory conditions have been corrected.
- Examine roughing-in of fire-suppression piping systems. Verify actual locations of piping connections before pump installation.

Z220C.130 CONCRETE BASES

- Install concrete bases of dimensions indicated, or otherwise required, for fire pumps, and controllers. Refer to Section "Cast-in-Place Concrete."

Z220C.140 INSTALLATION

- Comply with fire-pump, relief valves, accessories and controller manufacturers' written installation and alignment instructions, and with NFPA 20.
- Install pumps and controllers to provide access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.
- Set base-mounting-type pumps on concrete bases. Disconnect coupling halves before setting. Do not reconnect couplings until alignment operations have been completed.
    - Support pump baseplate on rectangular metal blocks and shims or on metal wedges having small taper, at points near foundation bolts to provide 19- to 38-mm gap between pump base and foundation for grouting.
    - Adjust metal supports or wedges until pump and driver shafts are level. Check coupling faces and pump suction and discharge flanges to verify that they are level and plumb.
- Install suction and discharge piping equal to or greater than diameter of fire-pump nozzles, and as required by NFPA 20.

- Install valves that are the same size as piping connecting fire pumps, bypasses, test headers, and other piping systems.

- Install pressure gages on fire-pump suction and discharge at pressure-gage tappings.

- Support pumps and piping separately so weight of piping does not rest on pumps.

- Install piping accessories, hangers and supports, anchors, valves, meters and gages, and equipment supports according to NFPA 20.

- Install fuel system according to NFPA 20.

- Install water supply and drain piping for diesel-engine heat exchangers. Extend drain piping from heat exchangers to point of disposition.

- Install exhaust system piping for diesel engines. Extend to point of termination outside structure. Install pipe and fittings with welded joints, and components having flanged connections with gasketed joints.

- Install condensate drain piping for diesel-engine exhaust system. Extend drain piping from low points of exhaust system to condensate traps and to point of disposition.

- Install flow meters and sensors where indicated. Install flow-measuring-system components and make connections according to NFPA 20 and manufacturer's written instructions.

- Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted. Furnish copies of manufacturers' wiring diagram Submittals to electrical Installer.

    - Verify that electrical wiring is installed according to manufacturers' submittal and installation requirements in Division 26 Sections. Proceed with equipment startup only after wiring installation is satisfactory.

Z220C.145 PRESSURE MAINTENANCE PUMPS INSTALLATION

- NFPA Standard: Comply with NFPA 20 for installation of pressure-maintenance pumps.

- Base-Mounted Pump Mounting: Install pumps on concrete bases.

    - Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
    - For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
    - Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
    - Install anchor bolts to elevations required for proper attachment to supported equipment.
    - Attach pumps to equipment base using anchor bolts.

- Install multistage, pressure-maintenance pumps according to HI 1.4.

Z220C.150 ALIGNMENT

- Align fire-pump and driver shafts after complete unit has been leveled on foundation, grout has set, and foundation bolts have been tightened.

- After alignment is correct, tighten foundation bolts evenly but not too firmly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten foundation bolts after grout has hardened. Check alignment and make required corrections.

- Make piping connections, check alignment, and make required corrections.

    - Align pump and driver shafts for angular and parallel alignment according to HI 1.4.
    - Alignment Tolerances: Comply with manufacturer's written instructions.

Z220C.160 CONNECTIONS

- Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties. The following are specific connection requirements:

    - Install piping adjacent to fire pumps and equipment to allow service and maintenance.
    - Connect fire-pump discharge piping to building fire-suppression piping.
    - Connect relief-valve discharge to point of disposal.
    - Connect cooling-system water supply and drain piping to diesel-engine heat exchangers.
    - Connect exhaust system piping to diesel engines.

- Connect flow-measuring-system meters and sensors according to manufacturer's written instructions.

- Connect fire-pump controllers to building fire alarm system.

- Connect controllers to pumps.

- Ground equipment.

    - Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

- Support exhaust system from building structure using rigid structural shapes for attachment of fixed point supports (Plate Support Assembly). Anchor supports to structure by welding, bolting, steel expansion anchors, or concrete inserts. Size of structural shapes shall be in accordance with manufacturer’s recommendations.

- Protect incomplete chimney installations by attaching temporary closures over open ends of sections.

- Clean all exhaust system sections of dust and debris prior to final connection to appliances.

Z220C.170 IDENTIFICATION

- Identify system components. Comply with requirements for fire-pump marking according to NFPA 20 and Section Z254.

Z220C.180 FIELD QUALITY CONTROL

- Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including fire-pump and pressure-maintenance-pump units, piping, and electrical connections. Report results in writing.
    - Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
    - Check suction line connections for tightness so no air gets into pumps.
    - Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation. Remove malfunctioning units, replace with new units, and retest.
    - Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
    - Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Fire hoses are for field-acceptance tests only and are not property of Employer.
    - Final Checks before Startup: Perform the following preventive-maintenance operations and checks:
        - Lubricate oil-lubrication-type bearings.
        - Remove grease-lubrication-type bearing covers, flush bearings with kerosene, and clean thoroughly. Fill with new lubricant according to manufacturer's written instructions.
        - Disconnect coupling and check electric motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
        - Verify that pump is free to rotate by hand. If pump is bound or if it drags even slightly, do not operate until cause of trouble is determined and corrected.
    - Starting procedure for electric driven pumps is as follows:
        - Prime pump by opening suction valve and closing drains, and prepare pump for operation.
        - Open sealing liquid supply valves if pump is so fitted.
        - Start motor.
        - Open discharge valve slowly.
        - Observe leakage from stuffing boxes and adjust sealing liquid valve for proper flow to ensure lubrication of packing. Do not tighten gland immediately but let packing run in before reducing leakage through stuffing boxes.
        - Check general mechanical operation of pump and motor.
    - Starting procedure for diesel engine driven pumps is as follows:
        - Install coolant in cooling system. Fill closed-loop cooling system with potable water and add rust inhibitor.

- Install coolant in cooling system. Fill closed-loop cooling system with solution of 50 percent potable water and 50 percent ethylene glycol permanent antifreeze. Add rust inhibitor if not in antifreeze.
- Prime pump by opening suction valve and closing drains, and prepare pump for operation.
- Open sealing liquid supply valves if pump is so fitted.
- Start engine.
- Open discharge valve slowly.
- Observe leakage from stuffing boxes and adjust sealing liquid valve for proper flow to ensure lubrication of packing. Do not tighten gland immediately but let packing run in before reducing leakage through stuffing boxes.
- Check general mechanical operation of pump and driver.

- Perform field tests for each fire-pump unit and system piping when installation is complete. Comply with operating instructions and procedures in NFPA 20 to demonstrate compliance with requirements. Where possible, field correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment that cannot be satisfactorily corrected or that does not perform as indicated, then retest to demonstrate compliance. Verify that each fire-pump unit performs as indicated. Report test results in writing.

Z220C.190 DEMONSTRATION

- Engage a factory-authorized service representative to train Employer's maintenance personnel to adjust, operate, and maintain fire pumps.

  - Schedule at least 8 (eight) hours of training.

Z221 - WATER TANKS AND CISTERNS

221.010 GENERAL

- Comply with work section general below
    - Tank design - reference Y21.1010
    - Domestic storage water cisterns - reference Y21.1020
        - BS EN 12845
        - Loss Prevention Certification Board (LPCB) standard LPS 1276.

221.040 GLASS REINFORCED PLASTICS SECTIONAL TANK TO BS EN 13280:

- Type
- Application
    - Cold water storage for domestic water use.
- Sectional A1 - reference Y21.2020A (for potable water incorporating screened air inlet, vent pipe entry device for the cover, screened)
- Sectional A2 - reference Y21.2020B (For potable water)
- Access ladders
- Manholes or access hatches
    - 600mm diameter.
    - 600mm square
- Raised level control valve chamber.
- Limiting conditions
    - In a building.
- Special requirements
    - Venting Level switches

221.100 WORKMANSHIP:

- General - reference Y21.4010
- Protection and cleaning - reference Y21.4020
- Inspection and access - reference Y21.4030

Z223 - STORAGE CYLINDERS AND CALORIFIERS

223.010 GENERAL:

- Hot water storage tanks / vessels to comply with EU Regulation 814/2013 with regard to ecodesign requirements (limiting standing loss and product information).
- Comply with work section general clauses below
    - Standards - reference Y23.1010
    - Definitions - reference Y23.1020

223.090 CALORIFIER AND STORAGE VESSELS TO BS 853-1:

- Galvanised steel with sacrificial anode
    - Reference Y23.2060A
- Duty
    - Primary Medium
        - Hot water
- Type of heater
    - Helical coil.
        - Fixed.
- Independent inspection requirements
    - Welding as BS 853-1
    - Factory inspection as BS 853-1
- Factory applied insulation
- Insulation jacket to BS 5615

223.110 WORKMANSHIP:

- General - reference Y23.3010
- Flange drillings - ensure flange drillings are uniform to facilitate interchange of tube assemblies.
- Protection and cleaning - reference Y23.3030
- Inspection and cleaning - reference Y23.3040

Z225 - CLEANING AND CHEMICAL TREATMENT

225.010 GENERAL:

- The specifications of this section applies to HVAC, plumbing, and firefighting works.
- Comply with work section general clauses below

    - Conditions for cleaning and chemical treatment - reference Y25.1010
    - Method statement - reference Y25.1015

- Supply cleaning and chemical treatment as specified
- Comply with Approved Codes of Practice and associated technical guidance published by HSE on the requirements of the Health and Safety at Work etc. Act 1974 and the Control of Substances Hazardous to Health Regulations 2002 as amended, that apply to the risk from exposure to legionella bacteria.

225.020 CLEANING AND CHEMICAL TREATMENT SPECIALIST:

- Reference Y25.2010
- On closed systems the specialist shall, in addition to specific requirements detailed elsewhere in this specification or drawings, undertake the following:

    - Obtain relevant information on the closed system to be treated.
    - Evaluate which treatment options will achieve the corrosion control and water quality objectives, taking account of regulatory issues and product selection constraints.
    - Follow up the treatment programme with proper monitoring of chemical, microbiological and physical parameters, ideally including monitoring of corrosion rates.

225.030 MAINS WATER ANALYSIS:

- Reference Y25.2020A
- The following is an analysis of mains water taken from site supply point:-

    - Conductivity (uS/cm)
    - Total Dissolved Solids (mg/l)
    - pH
    - Chloride Cl (mg/l)
    - Calcium Ca (mg/l)
    - Magnesium Mg (mg/l)
    - Sodium Na (mg/l)
    - Potassium K (mg/l)
    - Total Hardness $CaC0_3$
    - Alkalinity $CaC0_3$
    - Total Iron Fe (ug/l)
    - Copper Cu (ug/l)
    - Total Viable Count (cfu/ml)
    - Pseudomonas (cfu/100ml)

225.040 PRELIMINARY CHECKS:

- Reference Y25.2030A

225.050 PROCEDURAL PRECAUTIONS:

- Reference Y25.2040A
- Including taking samples - reference Y25.2040B

225.060 CHEMICAL INJECTION AND DOSING METHODS:

- Water treatment methods
    - Water treatment methods for hot water heating closed circuit recirculating systems - reference Y25.2050A
    - Water treatment methods for chilled and condenser water closed circuit recirculating systems - reference Y25.2050B

- **Method of introducing chemicals into closed systems - reference Y25.2060A**
- **Method of introducing chemicals into open recirculating systems - reference Y25.2060B**
- Packaged plant - reference Y25.2060C
- Dosing for closed systems - reference Y25.2060D
- Dosing for open systems - reference Y25.2060E
- Dosing chemicals - reference Y25.2065

225.065 CORROSION TEST COUPON RACKS:

- Type
    - Serpentine, incorporating isolation valves on both sides of the rack and built-in flow control to hold the water flow through the rig at the ASTM recommended velocity of 0.6m/s to 1.8m/s.

- Standard
    - ASTM D2688

- Rack material
    - Mild steel

- Install rack in accordance with the manufacturer's recommendations.
- Provide corrosion coupons for monitoring the system for a period after handover.
-

225.070 MONITORING AND SAMPLING:

- Monitoring closed systems - reference Y25.2070A
- Sampling closed systems - reference Y25.2070B

- Sampling hot and cold water services - reference Y25.2070E

- Sampling kits - reference Y25.2070C
- Monitoring of open systems - reference Y25.2070D

225.080 CHEMICAL PROVISION:

- Standard arrangement - reference Y25.2080A

225.090 FLUSHING:

- Application
  - Heating, cooling and other closed pipework systems
    - BSRIA Guide BG 29/2012 - Pre-commission Cleaning of Pipework Systems - reference Y25.3010A
    - System filling
      - Temporary connection from mains in compliance with
      - England and Wales - The Water Supply (Water Fittings) Regulations 1999 as amended, the Water Act 2014 and The Construction Products Regulations 2013.
      - Scotland - The Water Supply (Water Fittings) Byelaws 2014.
      - Northern Ireland - The Water Supply (Water Fittings) Regulations 2009.]
      - Temporary connection from fire hydrant pipework.]
      -
    - Flushing - reference Y25.3010B
  - Flush system until discharge water is visually clear.
- Services supplying water for domestic use - reference Y25.3010D
- –

225.110 CHEMICAL CLEANING AND SOLIDS REMOVAL:

- Water quality required after final flushing
  - As BSRIA BG 29.
- BSRIA Application Guide 29/2012: Pre-commission Cleaning of Pipework Systems.
  - Inhibited acid - reference Y25.3030A
  - Formulated products - reference Y25.3030B
- Cleaning and chemical treatment regime - reference Y25.3035

225.120 DISINFECTION:

- General - reference Y25.3040
- Hot and cold water systems - reference Y25.3050
- Water storage systems - reference Y25.3060

225.140 SERVICE VISITS:

- Reference Y25.3080
- Special requirements

    - Include for 6 visits during the first 2 months commissioning.
    - Provide 1 annual review of system.
    - 4 times per annum send samples to an independent laboratory for differential micro-biological analysis.
    - Include for carrying out all necessary maintenance and inspections during the first 12 months following, the agreed date of practical completion.
    - Use only fully qualified operatives for any maintenance carried out.

225.150 DOCUMENTATION:

- Reference Y25.3090

Z230 – AIRDUCTS AND ANCILLARIES

230.010 GENERAL:

- Comply with work section general clauses below
    - Ductwork installation standards - reference Y30.1010
    - Ductwork dimensions - reference Y30.1020
    - Electrical bonding terminal - reference Y30.1030
- Fire stopping
    - All components forming the seal system to be from the same manufacturer. All products used, to have third party product certification by a scheme accredited by UKAS.
    - Only use UKAS accredited or Local Authority approved, third party installer certified contractors. The contractor should be ASFP members and their certification must cover the passive fire protection element they are installing.
    - Install all fire stopping systems in accordance with the manufacturer's written instructions and the test / assessment / certification evidence provided by the installer / manufacturer of the penetration seal.
    - Support centres for services passing through penetration seals serving fire barriers to be the same as those covered by the test / assessment / certification evidence provided by the installer / manufacturer of the penetration seal.
    - Install and inspect fire stopping systems in accordance with Building Regulations Approved Document B, ASFP Code of Practice TGD 17 and general best practice guidance given in the ASFP On-site guide to installing fire-stopping.

230.020 INSTALLER SELECTION:

- Where post installation cleaning is specified, appoint a cleaning contractor to undertake the work in accordance with BESA TR/19, and supply and install any additional cleaning openings to suit their selected specific methods of cleaning and to suit the practical site conditions relative to the fabric of the building and position of other services.

230.030 DUCTWORK AND FITTINGS:

- Electrical bonding terminal - reference Y30.1030
- Design Information
    - Pressure classification – reference Y30.2010#
    - Cleanliness quality class to BS EN 15780 and BESA TR/19
        - Prior to final commissioning, in addition to a visual assessment of the internal surfaces, undertake Preferred Vacuum Test (PVT) to establish dust accumulation level is within the acceptable level for the cleanliness quality class listed in Table 2 (A.4) in BESA TR/19.
    - Protection Delivery and Installation (PDI) level to BS EN 15780 and BESA TR/19
        - Advanced (including post installation cleaning) - reference Y30.4090C

- Post installation cleaning for advance level of PDI
    - To be undertaken by a ductwork cleaning contractor.
    - Dry method - reference Y30.4090D
    - Wet method - reference Y30.4090E
- Flexible ductwork
    - Aluminium - reference Y30.3100B
    - Flexible ductwork installation - reference Y30.4015
- Spark testing on plastics ductwork - reference Y30.2025
- Ductwork air leakage testing
    - High pressure ductwork - reference Y30.2030A
    - Medium pressure ductwork - reference Y30.2030B
    - Low pressure ductwork - reference Y30.2030C
- Ductwork strength and air leakage testing, circular sheet metal ductwork - reference Y30.2035.
- Ductwork strength and air leakage testing, rectangular sheet metal ductwork - reference Y30.2036.
- Floor plenum airtightness testing - reference Y51.2015.

230.040 SHEET METAL DUCTWORK TO DW/144:

- Type
    - Application: General
    - Material
        - Zinc coated. Hot-dip galvanized steel to BS EN 10346.
    - Protective finishes
        - Galvanizing.
    - Construction
        - Rectangular.
    - Man access and safety bars - reference Y30.2070
- Type
    - Application: Locker shower rooms exhaust
        - Material
            - Aluminium.
    - Construction
        - Rectangular.

- Man access and safety bars - reference Y30.2070

230.045 SHEET METAL DUCTWORK OFR KITCHENS TO DW/172:

- Type
  - Application: Concealed grease hood exhaust
    - Grease hood extract - reference Y30.2065
  - Material
    - Mild steel.
  - Protective finishes
    - Galvanizing.
  - Construction
    - Rectangular.
  - Man access and safety bars - reference Y30.2070

- Type
  - Application: Exposed grease hood exhaust and Dishwasher hood exhaust
    - Grease hood extract - reference Y30.2065
  - Material
    - Stainless steel.
  - Construction
    - Rectangular.
  - Man access and safety bars - reference Y30.2070
- Kitchen extract to be fire resisting as per clause Y30.2110D or Y30.2110E

230.071 FIRE RESISTING SMOKE EXTRACT DUCTWORK AND METHOD OF MAINTAINING FIRE INTEGRITY:

- Install and inspect fire resisting duct systems in accordance with Building Regulations and ASFP Code of Practice TGD 18.
- The installation shall be fully in accordance with the test certification.
- Supply fire resisting ductwork as below

- Duct type
    - Fire inside smoke control duct Type C
    - Application
        - Smoke and heat removal
    - Fire resistance when tested to the requirements of BS EN 1366-8 or BS EN 1366-9 and classified in accordance with BS EN 13501-4 for smoke control ducts using BS EN "EI" nomenclature by UKAS accredited certification body.
        - Integrity: 120 mins
        - Insulation: 120 mins
    - Fire rating when tested to the requirements of BS 476-24 by a UKAS accredited certification body.
    - Pressure class of ductwork to BESA DW/144
- Standards
    - Smoke and heat control duct systems to BS EN 12101-7
    - BS 9999 for general fire safety
    - BS EN 1363-1 Fire resistance tests. General requirements
    - BS EN 1366-8 Fire resistance tests for service installations. Smoke extraction ducts
    - BS EN 1366-9 Fire resistance tests for service installations. Single compartment smoke extraction ducts
    - BS EN 13501-4 Classification using data from fire resistance tests on components of smoke control systems
    - BS 476-24
- Methods of fire rated smoke extract ductwork
    - Fire resisting ductwork
        - Contractor shall submit clear method statement for the constructing of fire/ smoke rated ducts compliant with the below relevant standards and references for approval, such as applying fire resistant coating, or by treating the duct on-site (i.e. externally encasing with insulation or fire rated boards.
        - Fire resisting and smoke extract ductwork, tested to BS 476-24 - reference Y30.2110C
        - Fire resisting and smoke / heat control ductwork tested to BS EN 1366 - reference Y30.2110F
- The manufacturer/installer shall be assessed and registered in accordance with BS EN ISO 9001
- Systems/materials shall be listed within the Loss Prevention Certification Board (LPCB) Red Book.
- Systems/materials used shall have third party accreditation by a UKAS accredited certification body, or a certification body approved by the local Authorities Having Jurisdiction.

230.090 SUPPORTS:

- Hangers and supports
    - Reference Y30.2140A
- Support of air terminal units
    - Reference Y30.2150A

230.100 ACCESSORIES:

- Construction and finishes - reference Y30.3010
- Inspection/servicing access openings
    - Metal ductwork - reference Y30.3020A
    - BESA TR/19 - reference Y30.3020D
- Test holes
    - Metal ductwork - reference Y30.3030A
- Holes for controls/instruments - metal ductwork - reference Y30.3040
- Controls/sensing equipment - plastics ductwork - reference Y30.3041
- Installation of instruments and controls - reference Y30.3042
- Cleaning access
    - Advanced level of PDI with post installation cleaning - reference Y30.3050C
- Flexible ducts
    - Aluminium - reference Y30.3100B
- Flexible joint connections
    - Reference Y30.3110A

230.110 REGULATING DAMPERS - METAL DUCTWORK:

- Acoustic testing requirements to BS EN ISO 5135
- Balancing dampers
    - Steel single-blade dampers - reference Y30.3060A
    - Steel multi-blade dampers - reference Y30.3060B
- Control dampers
    - Steel single-blade dampers - reference Y30.3060C
    - Steel multi-blade dampers - reference Y30.3060D
- Steel backdraft regulating dampers - reference Y30.3060F

230.130 FIRE DAMPERS:

- General - reference Y30.3075
- Folding curtain
    - Steel
        - Blades partially in air stream - reference Y30.3070A
        - Out of air stream - reference Y30.3070C
    - Stainless steel
        - Blades partially in air stream - reference Y30.3070B
        - Out of air stream - reference Y30.3070D
- Steel single-blade - reference Y30.3070E]
- Stainless steel single blade - reference Y30.3070F
- Steel multi-blade - reference Y30.3070G
- Stainless steel multi-blade - reference Y30.3070H
- Intumescent - reference Y30.3070I
- Fire damper accessories - reference Y30.3070J
- Fire stops - plastics ductwork - reference Y30.3071

230.140 SMOKE DAMPERS:

- General - reference Y30.3079
- Steel single-blade
- Steel multi-blade
- Reference Y30.3080#
- Smoke control dampers to be in accordance with BS EN 12101-8 tested to BS EN 1366-10 and classified in accordance with BS EN 13501-4.

230.150 COMBINATION SMOKE AND FIRE DAMPERS:

- General - reference Y30.3089
- Steel single-blade
- Steel multi-blade
- Reference Y30.3090#
- Combination smoke control / fire dampers to be in accordance with BS EN 12101-8 tested to BS EN 1366-10 and BS EN 1366-2 and classified in accordance with BS EN 13501-4.

230.160 GUARDS:

- Bird wire guards
    - Finish
        - Plastic coated wire - reference Y30.3120A

- Insect guards
    - Manufacturers standard
        - Woven wire cloth - reference Y30.3130A
- Kit form
    - Black high density polyethylene - reference Y30.3130B

230.180 AIR DUCTLINES & ANCILLARIES WORKMANSHIP:

- General - reference Y30.4010
- Ductwork supports - reference Y30.4020
- Component support on pre-insulated aluminium ductwork
    - Reference Y30.4025
- Duct support for vapour seal continuity
    - Reference Y30.4030A
- External ductwork
    - Construction
        - Galvanised steel to BESA DW/144 Section 26, protected from the elements by a watertight membrane installed immediately after the ductwork has been installed.
        - All welded construction using black mild steel sheet galvanised after manufacture refer to Appendix C in BESA DW/144, minimum thickness 1.6mm, flanged and all nuts, bolts and fixings shall be bright zinc plated.
        -
    - Protective finish
        - Aluminium cladding.
    - External ductwork supports - reference Y30.4040
- Ductwork floor support - reference Y30.4050
- Flexible ductwork installation - reference Y30.4015
- Drainage of ductwork - reference Y30.4060
- Connections to building openings
    - Metal ductwork, comply with DW/144, Appendix K.
- Weather proofing
    - Flashing plate and cowl - reference Y30.4100A
- Ductwork sleeves

    - Plain - reference Y30.4110A
    - Flanged - reference Y30.4110B

- Fire rated ductwork sleeves

    - Provide as indicated on drawing.

- Installation of control equipment

    - Reference Y30.4130
    - Positions

        - Position components as indicated and in accordance with manufacturer's instructions as shown on the following drawings

            - Contract drawings.
            - Manufacturer's drawings.
            - Supplier's drawings.
            - Contractor's drawings.

- Instrument connections

    - Reference Y30.4140

- Damper access - reference Y30.4160

230.190 PRESSURE EQUIPMENT DIRECTIVE/PRESSURE EQUIPMENT REGULATIONS:

- All equipment and assemblies which fall within the scope of the Pressure Equipment Directive (PED) 2014/68/EU must be tested by the manufacturers, and be certified as compliant with the Directive. Such compliance shall be evidenced by displaying the appropriate CE Mark on the equipment and assemblies.
- Only relevant equipment and assemblies certified as compliant will be permitted under this specification, and any substitution put forward must also be compliant with the Directive.

230.200 VAV /CAV TERMINAL UNITS:

- Provide variable / constant air volume units with facility to limit air flow between pre-set minimum and maximum limits. Ensure pressure drop across unit is less than 250 P at design flow rate. Pre-set air flow regulators at manufacturer's works.
- Pressure-independent devices venturi Valves, can be mounted next to an elbow, transitions or branches without affecting accuracy, valve mechanically correct static pressure fluctuations without involving a controller.
- Duty

    - Terminal heater battery
    - Sound attenuator

- Casing

        - Fabricate from mild steel sheets and stiffeners without sharp edges and incorporate fixing lugs. Do not use self-tapping screws.

    - Finish
        - Protect against corrosion internally and externally and finish with stoved primer
    - Duct Connections
        - Upstream
            - Suitable for attachment of circular connection.
        - Downstream - Flanged
    - Components
        - Self-acting constant volume control to maintain air quantity to plus or minus 5 per cent of design quantity up to 2 kPa air static pressure.
        - Acoustic insulation lining.
        - Device actuated by thruster responsive to thermostat to vary air flow.
    - Access
        - Provide access to moving parts by cover plate incorporating an air-tight seal. Ensure moving parts can be removed as one piece for single duct units.
    - Testing
        - Ensure manufacturer's ratings comply with BS EN 12589 and where appropriate BS 4857.

230.210 INSTALLATION:

- Install VAV / CAV terminal units in accordance with manufacturer's recommendations.

Z240 - AIR HANDLING UNITS

240.010 GENERAL:

- Comply with general clauses below
    - AHU's general mechanical performance and testing/rating - reference Y40.1000
    - AHU's generally for healthcare buildings and mechanical performance and testing / rating - reference Y40.1001
- Ensure all electrical equipment supplied and installed is suitable for the power supply indicated.
- Provide details of electrical input, starting and performance characteristics of all motors.
- Where appropriate ensure motors and drives are supplied complete with keys and keyways.
- Comply with section Y92A for specifications of starters and VSD
- Spare parts
    - Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
        - Filters: Furnish 1 set for each central-station air-handling unit.
        - Fan Belts: Furnish 1 set for each central-station air-handling unit fan.
        - Gaskets: Furnish 1 for each sectional joint of each central-station air-handling unit.

240.020 AIR HANDLING UNITS DUTY AND CONSTRUCTION:

- Air leakage
    - Casing air leakage class to BS EN 1886 - reference Y40.1010B
    - Filter bypass leakage - reference Y40.1010C
- Unit Skin Type
    - Manufacturer’s standard
    - Reference Y40.2010#
    - Double skin unit
        - Manufacturer's standard
        - Reference Y40.2020#
- Air handling unit construction
    - Detail mechanical performance requirements to BS EN 1886
        - Casing strength class
            - D1.
        - Thermal transmittance class
            - T1.

- Thermal bridging class
    - TB1.
    - Reference Y40.2030#

- Air handling unit access
    - Reference Y40.2040A
    - Permanent access platforms for double deck AHU's reference Y40.2040B.

- External air handling units - Reference Y40.2060A

240.030 AIR HANDLING UNIT FANS:

- Standards - Reference Y41.1000
- Fan selection, efficiency and EC eco-design requirements for fans - reference Y40.1020
- Fan duty
    - Centrifugal fan
        - Double inlet double width
            - Backward curved
            - Airfoil blades
            - Reference Y41.2080C
    - Overall total efficiency of fan and motor/drive combination (%) as defined in BS EN ISO 12759
    - Limiting Fan Motor Efficiency Grade to BS EN ISO 12759 (FMEG)

- Motor
    - Type
        - Asynchronous induction.
        - Asynchronous induction with VSD.
        - Permanent-Magnet Synchronous with VSD.
        - Magnet free synchronous reluctance fitted with VSD.
        - EC Permanent-Magnet Synchronous with integral AC to DC converter and electronic controls with 0-10V control input.
        - EC Permanent-Magnet Synchronous with integral AC to DC converter and electronic controls with 0-10V control input and integral PID controller to enable sensors to be connected directly to the motor.]
    - Standards - reference Y92.1010
    - General - reference Y92.2020
    - For belt driven fan, fit motors on slide rails - reference Y92.2030
    - Motor efficiency
        - For VSD motors: Efficiency class IE2, reference Y92.2025A
        - For constant speed motors: Efficiency class IE3, reference Y92.20205B

- Vibration isolation
    - Fan and motor
        - Mount fan/motor on galvanized steel frame with vibration isolators
        - Mount fan on spring isolators with 50mm as minimum static deflection
    - Casing - No vibration is to be transmitted to casing
- Fan section - Reference Y40.3010#

240.040 AIR HANDLING UNIT FILTER:

- Refer to clauses under Z242 / Y 42 Reference clauses for details / materials and workmanship requirements.

240.050 AIR HANDLING UNIT HEATING COIL:

- Refer to Z243 series of clause / Y 43 Reference clauses for details / materials and workmanship requirements.
- Reference Y40.3030
- Type
    - Heater Battery – Electric - Reference 243.050

240.060 AIR HANDLING UNIT COOLING COIL:

- Refer to Z243 series of clauses / Y 43 Reference clauses for details / materials and workmanship requirements.
- Reference Y40.3040
- Type
    - Chilled Water-Cooling Coil - Reference 243.030

240.070 AIR HANDLING UNIT HEAT RECOVERY EQUIPMENT:

- Refer to Z243 series of clauses / Y 43 Reference clauses for details / materials and workmanship requirements.
- Type
    - Thermal wheel - Reference 243.060
- Reference Y40.3042

240.080 ULTRAVIOLET UV-C LAMP:

- Description:
    - UV-C lamp system consisting of power supply, power supply housing, wiring, UV lamp(s), lamp plug, lamp plug protector, encapsulated lamp, and lamp holder used for UV germicidal irradiation of cooling coil and condensate drain pan.
    - Factory installed and preengineered.

- Standard: UL Category Code ABQK, HVAC accessories, air-duct mounted or equivalent European standard.
- Lamps: High output, hot cathode.
- Lamp-Holder Construction:

    - UV- and moisture-resistant materials and designed to connect the lamp to the plug.
    - Adjustable positioning.

- Lamp-Clamp Construction:

    - UV- and moisture-resistant materials, water-tight connection.
    - Adjustable positioning.

- Lamp Protection: Hermetically sealed to provide protection against lamp breakage and to ensure lamp contents from a broken lamp are contained.
- Lamp Output: UV-C energy, primarily at the 254-nm wavelength with a 360-degree energy distribution.
- Access Door Interlocks: Automatic disconnect on all access doors into UV-installed casing sections to shield servicing personnel from contact with light.
- Power Supply: UL-listed, single-point electrical connection with service disconnect.
- Power Consumption: Maximum of 161 W/sq. m

240.090 AIR HANDLING UNIT ATTENUATOR:

- Refer to Z245 series of clauses / Y 45 Reference clauses for details / materials and workmanship requirements.

240.110 AIR HANDLING UNIT VIBRATION ISOLATION EQUIPMENT

- Refer to Z252 series of clauses / Y 52 Reference clauses for details / materials and workmanship requirements.

240.130 ACCESSORIES:

- Drainage from air handling unit components

    - Refer to Z243 series of clauses / Y 43 Reference clauses for details / materials and workmanship requirements.
    - Reference Y40.3050

- Control dampers

    - Reference Y40.3060#

- Lighting

    - Provide a suitably IP rated bulkhead fitting in each of the AHU access sections and fan sections.
    - Provide switch mounted on the side of the unit.
    - Provide all wiring as part of AHU package. Terminate in a terminal box mounted on the unit.

240.140 WORKMANSHIP:

- Component assembly
- Assemble air handling units using gaskets to prevent air leakage from casing.
- Ensure air handling units are positioned to allow adequate space for maintenance and access.
- UV-C lamp system installation:

    - UV-C lamp systems shall constitute of UV-C lamps installed before, and after air handling unit cooling coil to be sized and arranged by the manufacturer to achieve the design requirements.
    - Irradiation: Quantity of UV lamps are to be installed to provide an equal distribution of available UV-C energy. When installed, UV-C energy produced shall be of the lowest possible reflected and shadowed losses, distributed in a 360-degree pattern within the cavity or plenum space.
    - Intensity: UV-C lamp system modeling shall be included in the submittal and must contain necessary calculations to demonstrate the following:

        - For coils disinfection: A minimum of (64.6 W/sq. m) of coil surface area to achieve a minimum of 100 microwatts/sq. cm equally distributed on the target surface as recommended by ASHRAE.
        - For air disinfection: Array of UV-C lamps to be provided to deliver a minimum dose of 1500 microjoules/sq. cm total to air flowing through.

- Duct connections - reference Y40.4040
- Services connections - reference Y40.4050
- Isolation of units - reference Y40.4060
- Drainage of free water - reference Y40.4070
- Supports – on builders work base.

240.150 TESTING:

- Factory tests - reference Y40.4090#
- Testing prior to incorporation into works - reference Y40.4100#
- Fit clean filters in all air handling systems (AHU's and any duct mounted units) before the systems are commissioned under validation load conditions in accordance with Annex D in BS EN 13779.

Z241 - FANS

241.010 GENERAL:

- Comply with general clauses below
  - Standards - Reference Y41.1000
    - Fans for smoke and heat control to be in accordance with BS EN 12101-3
  - Design duties, fan selection, efficiency and EC eco-design requirements for fans and ventilation units - Reference Y41.1010
  - Protection - Reference Y41.1020
- Ensure all electrical equipment supplied and installed is suitable for power supply indicated.
- Provide details of electrical input, starting and performance characteristics of all motors above 750W to an agreed format.
- Where appropriate ensure motors and drives are supplied complete with keys and keyways.
- Comply with section Y92A for specifications of starters and VSD
- Spare parts
  - Furnish one set of belts for each belt-driven fan that match products installed, are packaged with protective covering for storage, and are identified with labels clearly describing contents.
- Duty
  - Overall total efficiency of fan and motor/drive combination as defined in BS EN ISO 12759
  - Limiting Fan Motor Efficiency Grade to BS EN ISO 12759 (FMEG)
- Operating conditions
  - Supply fan to suit environment subject to
    - Contaminants
    - Weather conditions
    - Risk of impact
    - Risk of explosion: for hazardous exhaust.
    - Non-overloading requirement
  - Potentially explosive atmospheres - reference Y41.2010B
- Normal operating conditions – Reference Y41.2010A
- Construction and handling - Reference Y41.2020A
- Testing - Reference Y41.2030

241.020 FAN AND MOTOR:

- Type
  - Axial flow fan
    - Operation
      - Single.
      - [Two in series.]
    - Impellers
      - Fixed pitch.
      - Adjustable pitch.

- Casing
    - Enclosed motor and impeller
    - Reference Y41.2070#
- Inspection doors - reference Y41.3010
- Guide vanes - supply fan with guide vanes as indicated.

- Centrifugal fan
    - Single inlet single width
    - Double inlet double width
    - Reference Y41.2080#
    - Inspection doors - reference Y41.3020
- Propeller fan
    - Reference Y41.2090A
    - Inspection doors for diaphragm mounted fans - reference Y41.3030
- Mixed flow fan
    - Reference Y41.2100A
    - Inspection doors - reference Y41.3040
    - Fit automatically controlled guide vanes.
- Roof mounted fan
    - Single fan
    - Twin fan with automatic changeover
    - Reference Y41.2110#
- In line fans
    - Reference Y41.2120#
    - Installation arrangement in accordance with BS EN ISO 5801 and BS EN ISO 13349
        - A: free inlet - free outlet.
        - B: free inlet - ducted outlet.
        - C: ducted inlet - free outlet.
        - D: ducted inlet - ducted outlet.

- Materials
    - Construct casing from galvanized sheet steel in accordance with BS EN 10346 or BS EN 10143
    - Construct casing from mild steel coated with epoxy polyester finish.
- Motor
    - Type
        - Asynchronous induction with Variable Speed Drive (VSD).
        - Asynchronous induction single speed.
        - Permanent-Magnet Synchronous, with Variable Speed Drive (VSD).
        - Magnet free synchronous reluctance with VSD.
        - EC Permanent-Magnet Synchronous with integral AC to DC converter and electronic controls with 0-10V control input.
        - EC Permanent-Magnet Synchronous with integral AC to DC converter and electronic controls with 0-10V control input and integral PID controller to enable sensors to be connected directly to the motor.

- Standards - reference Y92.1010
- General - reference Y92.2020
    - Provide protected enclosures against external mechanical impacts in accordance with BS EN 62262
        - IK 08
- For belt driven fan, fit motors on slide rails - reference Y92.2030
- Motor efficiency
    - For VSD motors: Efficiency class IE2, reference Y92.2025A
    - For constant speed motors: Efficiency class IE3, reference Y92.20205B
- Degree of protection in accordance with BS EN 60034-5
    - IP55.
- Method of motor cooling in accordance with BS EN 60034-6
- Surge suppressors
    - Manufacturer fitted - reference Y92.1040#
- Motor operating conditions
    - Standard operating conditions
    - Non-standard operating conditions (above 1000m with air conditions exceeding 40°C)
- Motors - over temperature protection
    - Thermistors - reference Y92.2060A
- Drives
    - Indirect drives
        - Toothed belt - reference Y92.2070A
        - Flat belt - reference Y92.2070B
    - Direct coupled drives - Reference Y92.2080A
    - Guards - Reference Y92.2090A
- Motor mounting classification - reference Y92.2100#

- Accessories
    - Guards - Reference Y41.3050A
    - Connections to duct - Provide matching flanges and flexible connections where indicated.
    - Shutters - Shutters to be fitted to prevent reverse flow through fan where indicated.
    - Mounting - Provide base frames/mounting brackets when there is an integral part of fan set.
    - Airflow sensor: Provide flow measurement facility - reference Y41.3110
    - Access – Provide access via hinged casing or removable panel

241.050 WORKMANSHIP

- Location - reference Y41.4010
- Attitude - reference Y41.4020
- Alignment - reference Y41.4030
- Testing - reference Y41.4040
- Drain connections - reference Y41.4050

Z242 - AIR FILTRATION

242.010 GENERAL

- Comply with work section general clauses below
    - Pressure loss data - reference Y42.1010
    - Air flow through media - reference Y42.1020
    - Seals - reference Y42.1030

242.020 FILTER:

- Type
    - Panel filter
        - Application: AHU Pre-Filter
        - Class to BS EN ISO 16890-1
        - Reference Y42.2040#
        - Filter Frame
            - Water resistant cardboard frame
            - Aluminum frame
            - Light gauge mild steel frame with corrosion resistant coating
    - Bag filter
        - Application: AHU Secondary Filter
        - Class to BS EN ISO 16890-1
        - Reference Y42.2050A
        - Terminal filter housing
            - Gasket seals - reference Y42.3030A
            - Steel frame with epoxy resin seal - reference Y42.3030B
        - Safe change filter changing unit
            - Mild steel
            - Stainless steel 316L
            - Reference Y42.3040#
    - Activated carbon filter
        - Media type in accordance with BS EN ISO 10121-1
        - Test complete devices and provide report in accordance with BS EN ISO 10121-2
        - Reference Y42.2080A
        - Media
            - Reactivated media.
        - Reference Y42.2090A
- Casings
    - With bolts, nuts and washers fixing - reference Y42.2010A
    - With captive nuts or tapped holes fixing - reference Y42.2010B
    - With clips - reference Y42.2010C
- Filter testing

- Test particulate air filters for general ventilation to BS EN 779
- Test air filters for general ventilation to relevant parts of BS EN ISO 16890
    - BS EN ISO 16890-2. Measurement of fractional efficiency and air flow resistance.
    - BS EN ISO 16890-3. Determination of gravimetric efficiency and air flow resistance versus mass of test dust captured.
    - BS EN ISO 16890-4. Conditioning method to determine the minimum fractional test efficiency
- Test complete gas phase air cleaning device and provide report in accordance with BS EN ISO 10121-2
- Accessories
    - Differential pressure indication
        - Dial gauge - reference Y42.3010A
        - Inclined manometer - reference Y42.3010B
        - Differential pressure switch - reference Y42.3010C
    - Filter housing
        - Provide filter housing to hold banks of filters rigidly in place.
    - Cleaning
        - Supply cleaning materials for metal plate filter, supply coating solution for one complete cleansing operation.

242.030 WORKMANSHIP:

- Access for maintenance
    - Reference Y42.4020A
    - Provide access
        - On upstream side of media.
        - On side of filter casing.
        - On bottom of filter casing.
        - From chamber on upstream side of media for front withdrawal.

Z243 - COILS, HEAT RECOVERY EQUIPMENT AND GAS / ELECTRIC BATTERIES

243.010 GENERAL:

- Where a heating or cooling coil, heater battery or heat recovery section forms part of an air handling unit.
    - Comply with the 240.050, 240.060 and 240.070 clauses and Y 40 References Clauses
    - Comply with relevant sections of BS EN 1886 and BS EN 13053
    - Coils shall be rated in accordance with BS EN 1216
    - Test the supply and extract sections of the AHU together as a single unit in accordance with BS EN 1886 and BS EN 13053 where a heat recovery device is included in the AHU.
- Heat exchangers and heat recovery equipment to comply with BS EN 305, BS EN 306, BS EN 307, and BS EN 308 as appropriate to the application.
- Comply with section Y92A for specifications of starters and VSD
- Spare parts
    - Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
        - Filters: Furnish one set of each type of filter specified.
        - Fan Belts: Furnish one set of belts for each belt-driven fan in energy recovery units.
        - Wheel Belts: Furnish one set of belts for each heat wheel.

243.030 CHILLED WATER COOLING COIL:

- Duty
    - Maximum working pressure (1380 kPa)
    - Coil test pressure (2070 kPa)
- Maximum air velocity
    - 2.5 m/s.
- Material
    - Tubes – Seamless round copper to BS EN 12451
    - Fins
        - Copper
    - Headers
        - Galvanized Steel
        - Copper with copper connections
    - Casing
        - Galvanized sheet steel in accordance with BS EN 10346 or BS EN 10143
        - Stainless steel
    - Reference Y43.2010#
- Accessories

- Drip tray - reference Y43.3010
    - Provide removable drip trays.
    - Material
        - 316 stainless steel.
- Drain traps
    - Material
        - Plastic.
    - Arrangement
        - Under suction
        - Reference Y3020#
- Eliminator plates - reference Y43.3030.
- Duct connections
    - In AHU - reference Y43.3050A
    - Duct Mounted
        - External flange - reference Y43.3050B
- Matching flanges ductwork - provide to suit coil.
- Matching flanges pipework - provide to suit coil.
- Anti-freeze thermostat - position where indicated.
- Auto air purging valve
- Access doors - provide to allow adequate access for maintenance. Provide access for cleaning to both sides of the coil on healthcare projects.
- Access walkway - provide for maintenance access.

243.050 HEATER BATTERIES - ELECTRIC:

- Duty
    - Maximum air velocity (m/s) 2.5
- Heater
    - Duct mounted - reference Y43.2040#
        - Flanged for rectangular ductwork.
        - Spigot connection for circular ductwork.
    - Heating element
        - Supply heating elements mounted on removable terminal plate
        - Metal sheathed tubular elements
        - Finned tubular elements
        - Open coil bare wire elements
- Casing
    - Material
        - Galvanized sheet steel
        - Stainless steel

- Finish – Manufacturer's Standard

- Control
  - Modulating thyristor control.
- Accessories
  - Matching flanges ductwork - provide to suit coil.
  - Access doors - provide to allow adequate access for maintenance.
  - Access walkway - provide for maintenance access.

243.060 THERMAL WHEELS:

- Type
  - Non-hygroscopic (heat transfer only)
  - Hygroscopic (heat and moisture transfer)
- Where the thermal wheel forms part of an air handling unit AHU, test the supply and extract sections together as a single unit in accordance with BS EN 1886 and BS EN 13053
- Materials
  - Rotor
    - Material
      - Epoxy coated aluminum for unit in corrosive environments
    - For enthalpy wheels, rotors are to be coated with silica gel.
  - Seals - Manufacturers' standard to suit environment.
  - Casing
    - Aluzinc steel for non-corrosive environment
    - Stainless steel for corrosive environment.
- Accessories
  - Bypass damper.
  - Adjustable purging sector.
  - Speed controller.
- Drive system
  - Motor
    - Motor with variable speed drive.
- Reference Y43.2060

243.100 WORKMANSHIP

- Position/location of coils and heat recovery equipment in distribution system - reference Y43.4010
- Connections
  - Cooling coil - reference Y43.4020A
  - Heating coil - reference Y43.4020B

- Coils to be fully supported independently of adjacent ductwork.
- Protection - reference Y43.4040
- Equipment installation - reference Y43.4050

Z245 - SILENCERS AND ACOUSTIC TREATMENT

245.010 GENERAL:

- Comply with work section general clauses below
    - Performance - reference Y45.1010
    - Testing - reference Y45.1020
    - Protection - reference Y45.1030
    - Direction of flow - reference Y45.1040
- Comply with IGEM/UP/10 and BS 6644 for silencers in fan diluted flue systems. Material of construction to be 304 stainless steel.
- Provide a 'Melinex' lining in front of the infill to prevent product migration or contamination of the infill in the following applications. Full account of the reduction in performance of the silencer brought about by the addition of the membrane shall be made when selecting silencers to meet the required performance
    - Healthcare premises

245.030 SILENCERS:

Insertion loss (dBA): according to the final acoustical study that intent to achieve the required noise level in the space

- Duty : Generator radiator fan, 2.4m length silencer
- Noise reduction spectrum
    - 63 Hz (dB) [11]
    - 125 Hz (dB) [19]
    - 250 Hz (dB) [30]
    - 500 Hz (dB) [50]
    - 1 kHz (dB) [50]
    - 2 kHz (dB) [43]
    - 4 kHz (dB) [34]
    - 8 kHz (dB) [28]
- Pressure rating of ductwork system: As designed.
- Resistance to air flow (Pa): As designed.
- Infill protection
    - Fibre glass scrim bonded to the rear of the linings and the galvanised sheet steel mesh of the splitter facings.
    - "Melinex" polyester film to be provided in front of the infill in the following applications:
        - Systems serving clinical areas in healthcare applications
        - Minimum thickness of Melinex film 23µm

- Full account of the reduction in performance of the silencer brought about by the addition of the infill protection shall be made when selecting silencers to meet the required performances.

- Fire properties
  - BS 476-7, Class 1
  - Building Regulations Class O
  - Reference Y45.2010#

- Circular silencers - metal
  - Casing to DW/144.
    - External flanges - reference Y45.2020A
    - Internal flanges - reference Y45.2020B
    - Spigot ends - reference Y45.2020C

- Circular silencers - non-metal
  - External flanges - reference Y45.2030A
  - Internal flanges - reference Y45.2030B
  - Plain spigot ends - reference Y45.2030C

- Rectangular silencers - metal
  - Casing to DW/144
    - Manufacturer's standard ends to splitters
      - Connections to match AHU - reference Y45.2040A
      - External flanges - reference Y45.2040B
      - Internal flanges - reference Y45.2040C
    - Low loss fairings
      - Connections to match AHU - reference Y45.2040D
      - External flanges - reference Y45.2040E
      - Internal flanges - reference Y45.2040F

- Rectangular silencers - non-metal
  - Manufacturer's standard ends to splitters
    - External flanges - reference Y45.2050A
    - Internal flanges - reference Y45.2050B
    - Spigot ends - reference Y45.2050C
  - Low loss fairings
    - External flanges - reference Y45.2050D
    - Internal flanges - reference Y45.2050E
    - Spigot ends - reference Y45.2050F

- Acoustic splitters
    - To manufacturer's standard - reference Y45.2060A
    - With low loss fairings - reference Y45.2060B
- Air transfer/cross talk attenuators
    - External flanges - reference Y45.2070A
    - Internal flanges - reference Y45.2070B
    - Spigot ends - reference Y45.2070C

245.060 ACOUSTIC FLEXIBLE CONNECTORS:

- Duty
    - Insertion loss (dBA) : according to the final acoustical study that intent to achieve the required noise level in the space
    - Pressure rating of ductwork system: As designed.
    - Resistance to air flow (Pa): as designed.
- Fire properties
    - BS 476-7, Class 1 - reference Y45.2010A
    - Building Regulations Class O - reference Y45.2010B
- Reference Y45.2110

245.070 ACOUSTIC LOUVRES:

- Manufacturer and reference
    - Use manufacturers of assessed capability to BS EN ISO 9001 and produce louvre to relevant Quality Assessment schedule.
- Duty: louvers in ancillary building.
    - Minimum noise reduction spectrum
        - 63 Hz (dB) [6]
        - 125 Hz (dB) [6]
        - 250 Hz (dB) [8]
        - 500 Hz (dB) [10]
        - 1 kHz (dB) [14]
        - 2 kHz (dB) [18]
        - 4 kHz (dB) [16]
        - 8 kHz (dB) [15]
- Fire properties
    - BS 476-7, Class 1 - reference Y45.2010A

- Building Regulations Class O - reference Y45.2010B

- Acoustic louvres

  - Reference Y45.2120A
  - With infill - reference Y45.2120B
  - Infill protection
  - Fibre glass scrim bonded to the rear of the linings and the galvanised sheet steel mesh of the splitter facings.
  - " Full account of the reduction in the performance of the acoustic louvre brought about by the addition of the infill protection shall be made when selecting silencers to meet the required performances.

- Arrangement

  - In breakdown form for site assembly.
  - In modular panel form.

    - For assembly on-site to form an enclosure complete with roof and door.

245.090 WORKMANSHIP

- Access to acoustic enclosures - reference Y45.3030
- Supports - reference Y45.3040
- Sound power level readings - reference Y45.3060

Z246 - GRILLES DIFFUSERS AND LOUVRES

246.010 GENERAL:

- Comply with work section general clauses below
    - Performance - reference Y46.1010
    - Size - reference Y46.1020
    - Noise levels - reference Y46.1030
    - Protective wrapping - reference Y46.1033
    - Electrical bonding terminal - reference Y46.1040

246.020 GRILLES:

- Subjected to engineer approval
    - Electrical bonding terminal - reference Y46.1040
    - Fixed blade type
        - Blade Rows
            - One set of straight blades.
            - One set of angled blades.
            - Horizontal.
            - Vertical.
        - Air pattern control
            - Rear set of individually adjustable blades perpendicular to front set.
            - Set fixed blades at angle to the horizontal as indicated.
        - Reference Y46.2010#
        - Material
            - Aluminum
            - Reference Y46.2210#
    - Adjustable blade type
        - Blade Angles
            - Allow each blade in a row of blades to be individually adjustable.
            - Allow all blades in a row to be linked and adjusted by an operating key or lever.
        - Reference Y46.2020#
        - Material
            - Aluminum
    - Mesh type
        - Core material
            - Cellular.
            - Expanded.
            - Perforated.
        - Frame
            - Flange mounting frame.

        - Plate flange.
    - Fixing
        - Designed for easy removal.
    - Material
        - Aluminum
        - Reference Y46.2210#
- Egg-crate type
    - Style
        - With flanged frame.
        - With channel frame.
    - Material
        - Aluminum
        - Reference Y46.2210#
- Linear type
    - Style
        - With flanged frame.
        - With housing frame without flanges.
        - Core collar.
    - Material
        - Aluminum
        - Reference Y46.2210#
    - Reference Y46.2050#
- Linear floor type
    - Loading
        - Pedestrian.
        - Computer room to special requirements.
    - Style
        - With flanged frame.
        - With housing frame without flanges.
        - For floor jack mounting.
        - Core collar.
    - Mounting
        - Secure blades within mounting frame.
        - Secure blade within floor opening.
    - Material
        - Aluminum
        - Reference Y46.2210#
    - Reference Y46.2060#
    - Fire resistant with intumescent element - reference Y46.2070C

- Fire rating (hrs) : as required

- Fire resistant with intumescent element and smoke control facility - reference Y46.2070D
  - Fire rating (hrs) : as required
- Mounting
  - Door
  - Wall
- Material
  - Aluminum
  - Reference Y46.2210#
- Reference Y46.2070#

- Grille and diffuser construction
  - Jointing corners
    - Mechanical.
  - Joint sheet metal by the following method
    - spot welding.
    - argon arc welding.
    - brazing.
    - riveting.
    - cold soldering.
    - other mechanical joints.
  - Reference Y46.2220A

- Accessories
  - Opposed blade volume control dampers
    - Local blade operation - reference Y46.3010A
  - Annular ring type volume control dampers
  - Butterfly volume control dampers
  - Iris volume control dampers
    - Reference Y46.3050A
  - Air flow deflector
  - Blanking plates - reference Y46.3070
  - Perforated screens - reference Y46.3090

246.030 DIFFUSERS:

- Subjected to engineer approval
  - Electrical bonding terminal - reference Y46.1040
    - Material
      - Aluminum
      - Reference Y46.2210#

- Reference Y46.2080#

- Linear type
  - Reference Y46.2090A
  - Air Controller
    - Fit each slot with
    - volume control device.
    - air equalising device.
    - directional control device.
  - Material
    - Aluminum
    - Reference Y46.2210#

- Perforated face type - reference Y46.2100
  - Material
    - Aluminum
    - Reference Y46.2210#

- Adjustable curved blade type
  - Fixed inner core
    - Control
      - 4 way control.
    - Reference Y46.2110#
  - Removable inner core
    - Control
      - 4 way control.
    - Reference Y46.2120#
  - Material
    - Aluminum
    - Reference Y46.2210#

- Straight line, fixed louvre type
  - Fixed inner core- reference Y46.2130A
  - Removable inner core - reference Y46.2130B
  - Control
    - [4 way control.]
  - Material
    - Aluminum
    -
    - Reference Y46.2210#

- Linear lighting/air modular type - reference Y46.2150
  - Material
    - Steel

        - Reference Y46.2210#
    - Laminar flow panels - reference Y46.2160
        - Material
            - Aluminum
            - Reference Y46.2210#
    - High induction diffusers
        - Secondary air induction - reference Y46.2170A
        - Turbulence/rotary motion - reference Y46.2170B
    - Extract/exhaust valve type - reference Y46.2180
        - Material
            - Aluminum
            - Reference Y46.2210#
    - Grille and diffuser construction
        - Reference Y46.2220A
    - Accessories
        - Opposed blade volume control dampers
            - Local blade operation - reference Y46.3010A
            - Remote blade operation - reference Y46.3010B
        - Annular ring type volume control dampers
            - Reference Y46.3030A
        - Butterfly volume control dampers
            - Reference Y46.3040A
        - Iris volume control dampers
            - Reference Y46.3050A
        - Air flow deflector
            - Fixed - reference Y46.3060A
            - Adjustable - reference Y46.3060B
        - Blanking plates - reference Y46.3070
        - Perforated screens - reference Y46.3090

246.031 LOUVER PENTHOUSES:

- Material
    - Aluminum
    - Reference Y46.2210#
- Colour
    - Subjected to engineer approval
- Construction

- All welded assembly
- Mitered corners
- Sheet roof
- Frame and blade thickness
    - At least 2 mm for extruded aluminum
- Exterior corners: Prefabricated corner units
    - mitered blades with concealed close-fitting splices
    - Mullions at corners
        - fully recessed
        -
- Bird screen: 12.7 mm square mesh
    - Aluminum
- Insect screen: 1.4 mm by 1.6 mm mesh
    - Aluminum
- Air performance
    - Maximum 25 Pa at 3.6 m/s free area velocity.

246.033 SWAN NECK:

- Material
    - Aluminum
    - Galvanized Steel
    - Reference Y46.2210#
- Construction
    - Factory or shop fabricated according to DW-144.
    - Bird screen: 12.7 mm square mesh
        - Galvanized steel
        - Aluminum
        - Stainless steel
    - Insect screen: 1.4 mm by 1.6 mm mesh
        - Aluminum
        - Stainless steel

246.070 GRILLES/DIFFUSERS/LOUVRES WORKMANSHIP:

- Grille/Diffuser location - reference Y46.4010
- Connection to ductwork - reference Y46.4040
- Installation in builders work
    - Reference Y46.4050A
- Transfer grilles
    - Reference Y46.4060A

- With fire damper - reference Y46.4060B

Z250a - THERMAL INSULATION - HVAC

250.010 GENERAL:

- Comply with work section general clauses reference below
    - Temperature range - reference Y50.1010
    - Standards - reference Y50.1020
    - Materials - reference Y50.1030
    - Pre-insulated equipment - reference Y50.1032
    - Protection applied in situ - reference Y50.1034
    - European classification for reaction to fire performance - reference Y50.1035A
    - Spread of flame - reference Y50.1050A
    - Smoke emission characteristics - reference Y50.1055
    - Electrical bonding terminal - reference Y50.1080
    - Inspection and testing - reference Y50.1090
- Allow for inspection of insulation on all systems for correct thickness and compliance with specification
- Insulation thicknesses
    - Reference Y50.2289

250.018 F GAS REGULATION:

- Use insulating materials that comply with EC Regulation 842/2006 The F Gas Regulation, on certain fluorinated greenhouse gases.

250.019 OZONE REGULATION:

- Use insulating materials that comply with EC Regulation 1005/2009 The Ozone Regulation, on substances that deplete the ozone layer.

250.040 CLOSED CELL MATERIALS THERMAL INSULATION - PIPEWORK:

- Application :chilled water, heating water, condensate pipes.
- Temperature of fluid in pipes :as designed
- Materials
- Thermal conductivity - reference Y50.2010
- Thermal performance life expectancy
    - For plant design life - reference Y50.2015A
    - Details - reference Y50.2015B
- Restrictions on use of materials - reference Y50.2020
- Closed cell rigid phenolic preformed sections
    - Foil faced - reference Y50.2110A
- High density rigid phenolic pipe and duct insulation - Reference Y50.2130A
- Closed cell nitrile rubber preformed flexible sections
    - Reference Y50.2140A
- Vapour barrier permeance
    - Reference Y50.2170

- Vapour barrier coatings
    - Bitumen - reference Y50.2180A
    - Vinyl - reference Y50.2180B
    - Solvent polymers- reference Y50.2180C
    - Bitumen emulsion- reference Y50.2180D
- Adhesives - reference Y50.2190
- Protection
    - Self-adhesive multi-layer laminate covering - reference Y50.2200A
    - Roofing felt - reference Y50.2200B
    - Flat aluminium-zinc coated steel - reference Y50.2200C
    - Ribbed aluminium-zinc coated steel - reference Y50.2200D
    - Aluminium sheeting - reference Y50.2200E
    - Canvas - reference Y50.2200G
    - Canvas with aluminium bands - reference Y50.2200H
- Reinforcement - Reference Y50.2210#
- Valve and flange insulation
- Thickness table
    - Insulation thickness calculation methods, ECA Enhanced - reference Y50.2287
    - Insulation thickness tables - reference Y50.2289
    - Non-domestic heating installations, ECA Enhanced maximum permitted heat losses - reference Y50.2327
    - Domestic central heating systems, ECA Enhanced maximum permitted heat losses - reference Y50.2331
- Thickness of insulation for refrigeration pipework to BS 5422 - reference Y50.2495#

250.050 CALCIUM SILICATE THERMAL INSULATION:

- Application : chimneys.
- Materials
- Thermal conductivity - reference Y50.2010
- Thermal performance life expectancy
    - For plant design life - reference Y50.2015A
    - Details - reference Y50.2015B
- Restrictions on use of materials - reference Y50.2020
- Calcium silicate preformed - reference Y50.2150
- Vapour barrier permeance
    - Reference Y50.2170
- Vapour barrier coatings
    - Bitumen - reference Y50.2180A
    - Vinyl - reference Y50.2180B
    - Solvent polymers- reference Y50.2180C
    - Bitumen emulsion- reference Y50.2180D
- Adhesives - reference Y50.2190
- Protection
    - Self-adhesive multi-layer laminate covering - reference Y50.2200A
    - Roofing felt - reference Y50.2200B
    - Flat aluminium-zinc coated steel - reference Y50.2200C
    - Ribbed aluminium-zinc coated steel - reference Y50.2200D

- Aluminium sheeting - reference Y50.2200E
- Canvas - reference Y50.2200G
- Canvas with aluminium bands - reference Y50.2200H

- Reinforcement - Reference Y50.2210#
- Valve and flange insulation
- Thickness of insulation to BS 5422 for process pipework and equipment- reference Y50.2490#
- Thickness of insulation to BS 5422 for refrigeration pipework and equipment - reference Y50.2495#

250.060 MINERAL WOOL THERMAL INSULATION - DUCTWORK:

- Temperature of fluid in ducts: as designed
- Materials
- Thermal conductivity - reference Y50.2010
- Thermal performance life expectancy
  - For plant design life - reference Y50.2015A
  - Details - reference Y50.2015B
- Restrictions on use of materials - reference Y50.2020
- Mineral wool duct insulation:
  - Rigid
    - Foil faced - Rock mineral wool reference Y50.2040A
    - Foil faced - Glass mineral wool reference Y50.2040B
  - Flexible
    - Foil faced - Rock mineral wool reference Y50.2050A], minimum density [28 kg/m3] [45 kg/m3
    - Foil faced - Glass mineral wool reference Y50.2050B], minimum density [28 kg/m3] [45 kg/m3
  - Lamella duct insulation
    - Foil faced - Rock mineral wool reference Y50.2060A, minimum density [45 kg/m3]
    - Foil faced - Glass mineral wool reference Y50.2060C, minimum density [45 kg/m3]
    - Kraft paper - Rock mineral wool reference Y50.2060B, minimum density[45 kg/m3]
    - Kraft paper - Glass mineral wool reference Y50.2060D, minimum density [45 kg/m3]
  - Crimped mat ductwork insulation - reference Y50.2065
  - Metal mesh faced mattresses for the insulation of high temperature ducts, tanks, vessels and other equipment
- Fire protection insulation
  - Flat ductwork
    - Mitred joints - reference Y50.2080A
    - Butted joints - reference Y50.2080B
  - Circular ductwor]
    - Section - reference Y50.2080C
    - PSM - reference Y50.2080D
  - Wired mattress - reference Y50.2080E

- Vapour barrier coatings, use vapor barriers on outside surface of insulation of cold services to prevent migration of atmospheric water vapor.
    - Bitumen - reference Y50.2180A
    - Vinyl - reference Y50.2180B
    - Solvent polymers- reference Y50.2180C
    - Bitumen emulsion- reference Y50.2180D
- Adhesives - reference Y50.2190
- Protection
    - Self-adhesive multi-layer laminate covering - reference Y50.2200A
    - Roofing felt - reference Y50.2200B
    - Flat aluminium-zinc coated steel - reference Y50.2200C
    - Ribbed aluminium-zinc coated steel - reference Y50.2200D
    - Aluminium sheeting - reference Y50.2200E
    - Canvas - reference Y50.2200G
    - Canvas with aluminium bands - reference Y50.2200H
- Reinforcement – Reference Y50.2210#
- Thickness table
    - Insulation thickness tables - reference Y50.2289
    - Condensation control on chilled air ductwork, rock mineral wool - reference Y50.2460
    - Condensation control on chilled air ductwork, glass mineral wool - reference Y50.2461

250.080 THERMAL INSULATION - PLANT:

- Materials
- Thermal conductivity - reference Y50.2010
- Thermal performance life expectancy
    - For plant design life - reference Y50.2015A
    - Details - reference Y50.2015B
- Restrictions on use of materials - reference Y50.2020
- Mineral fibre duct insulation
    - Rigid
        - Foil faced - reference Y50.2040A
    - Flexible
        - Foil faced - reference Y50.2050A
    - Lamella duct insulation
        - Foil faced - reference Y50.2060A
        - Kraft paper - reference Y50.2060B
    - Metal mesh faced mattresses
        - Galvanized mesh
            - One face - reference Y50.2070A
            - Both faces - reference Y50.2070B
        - Stainless steel mesh
            - One face - reference Y50.2070C
        - Both faces - reference Y50.2070D

- Closed cell rigid phenolic foam (PF) slab
    - Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.
    - Foil faced - reference Y50.2120A
    - Reference Y50.2120B]
- High density phenolic pipe and duct support foam
    - Reference Y50.2130A
    - Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.
- Closed cell nitrile and EPDM rubber elastomeric sheet and preformed sections.
    - Reference Y50.2140A
- Vapour barrier coatings
    - Bitumen - reference Y50.2180A
    - Vinyl - reference Y50.2180B
    - Solvent polymers- reference Y50.2180C
    - Bitumen emulsion- reference Y50.2180D
- Adhesives - reference Y50.2190
- Protection
    - Self-adhesive multi-layer laminate covering - reference Y50.2200A
    - Roofing felt - reference Y50.2200B
    - Flat aluminium-zinc coated steel - reference Y50.2200C
    - Ribbed aluminium-zinc coated steel - reference Y50.2200D
    - Aluminium sheeting - reference Y50.2200E
    - Canvas - reference Y50.2200G
    - Canvas with aluminium bands - reference Y50.2200H
- Reinforcement - Reference Y50.2210#
- Protection for heat exchangers and other vessels
    - Aluminium
        - Reference Y50.2230A
        - With chest covers - reference Y50.2230B
        - Aluminium-zinc coated steel
    - Multi-layer laminate - reference Y50.2230E
- Mineral wool insulation for boiler flues
    - With aluminium casing - reference Y50.2240A
- Supply pre-insulated boiler flues
- Supply cylinder jackets
- Pumps and other irregular shapes - reference Y50.2280
- Thickness of insulation
    - Unless specified otherwise elsewhere, the thicknesses for flat surfaces or irregular shaped plant items shall not be less than that for the largest pipe size given in the thickness tables below
    - Insulation thickness tables - reference Y50.2289
    - Non-domestic heating installations (Building Regulations)
        - Rock mineral wool - reference Y50.2310
        - Glass mineral wool - reference Y50.2315

- Domestic central heating systems, Building Regulations (rock mineral wool) - reference Y50.2330
- Insulation thickness on ductwork, Building Regulations - reference Y50.2456
- Condensation control on chilled air ductwork
    - Rock mineral wool - reference Y50.2460
    - Phenolic foam - reference Y50.2470
    - Closed cell nitrile foam - reference Y50.2475
- Thickness of insulation to BS 5422 for process pipework and equipment- reference Y50.2490#.
- Thickness of insulation to BS 5422 for refrigeration pipework and equipment -reference Y50.2495#

250.090 WORKMANSHIP PIPEWORK INSULATION:

- General - reference Y50.3010
- Installation of foil faced mineral wool insulation - reference Y50.3020
- Installation of foil faced phenolic foam insulation - reference Y50.3030
- Installation of closed cell nitrile rubber insulation - reference Y50.3050
- Installation of protection
    - Polyisobutylene (PIB) - reference Y50.3120
    - Self-adhesive multi-layer laminate covering - reference Y50.3125
    - Sheet metal finish
        - Reference Y50.3130A
    - Canvas - reference Y50.3150
    - Roofing felt - reference Y50.3160
    - Aluminium sheeting - reference Y50.3170
    - Aluminium-zinc coated steel - reference Y50.3180
    - Rigid PVC - reference Y50.3190
- Flanges and valves - reference Y50.3210
- Installation where insulation is carried through pipeline support
    - Reference Y50.3230A
    - Closed cell insulation - reference Y50.3230B
- Liquid vapour barriers - reference Y50.3260
- Integrity of vapour barriers - reference Y50.3270

250.100 WORKMANSHIP DUCTWORK INSULATION:

- General - reference Y50.3010
- Installation of foil faced rigid or slotted slab insulation - reference Y50.3060
- Installation of foil faced flexible insulation - reference Y50.3070
- Installation of foil faced lamella insulation - reference Y50.3080
- Installation of protection
    - Polyisobutylene (PIB) - reference Y50.3120
    - Self-adhesive multi-layer laminate covering - reference Y50.3125.
    - Sheet metal finish
        - Reference Y50.3140A
    - Canvas - reference Y50.3150
    - Roofing felt - reference Y50.3160
    - Aluminium sheeting - reference Y50.3170

        - Aluminium-zinc coated steel - reference Y50.3180
        - Rigid PVC - reference Y50.3190
    - Installation where insulation is carried through ductwork support - reference Y50.3250
    - Liquid vapour barriers - reference Y50.3260
    - Integrity of vapour barriers - reference Y50.3270

250.110 WORKMANSHIP EQUIPMENT INSULATION:

    - General - reference Y50.3010
    - Installation of insulation on tanks - reference Y50.3090
    - Installation of mineral wool insulation on vessels - reference Y50.3100
    - Installation of phenolic foam insulation on vessels - reference Y50.3110
    - Installation of protection
        - Polyisobutylene (PIB) - reference Y50.3120
        - Self-adhesive multi-layer laminate covering - reference Y50.3125
        - Sheet metal finish
            - Reference Y50.3140A
        - Canvas - reference Y50.3150
        - Roofing felt - reference Y50.3160
        - Aluminium sheeting - reference Y50.3170
        - Aluminium-zinc coated steel - reference Y50.3180
        - Rigid PVC - reference Y50.3190
    - Liquid vapour barriers - reference Y50.3260
    - Integrity of vapour barriers - reference Y50.3270

Z250b - THERMAL INSULATION - PLUMBING

250.010 GENERAL:

- Comply with work section general clauses reference below
    - Temperature range - reference Y50.1010
    - Standards - reference Y50.1020
    - Materials - reference Y50.1030
    - Pre-insulated equipment - reference Y50.1032
    - Protection applied in situ - reference Y50.1034
    - European classification for reaction to fire performance - reference Y50.1035A
    - Spread of flame - reference Y50.1050A
    - Smoke emission characteristics - reference Y50.1055
    - Electrical bonding terminal - reference Y50.1080
    - Inspection and testing - reference Y50.1090
- Allow for inspection of insulation on all systems for correct thickness and compliance with specification .
- Insulation thicknesses
    - Reference Y50.2289

250.018 F GAS REGULATION:

- Use insulating materials that comply with EC Regulation 842/2006 The F Gas Regulation, on certain fluorinated greenhouse gases.

250.019 OZONE REGULATION:

- Use insulating materials that comply with EC Regulation 1005/2009 The Ozone Regulation, on substances that deplete the ozone layer.

250.040 CLOSED CELL MATERIALS THERMAL INSULATION - PIPEWORK:

- Application :hot water supply / return.
- Thermal conductivity - reference Y50.2010
- Thermal performance life expectancy
    - For plant design life - reference Y50.2015A
    - Details - reference Y50.2015B
- Restrictions on use of materials - reference Y50.2020
- Closed cell rigid phenolic preformed sections
    - Foil faced - reference Y50.2110A
- High density rigid phenolic pipe - Reference Y50.2130A
- Closed cell nitrile rubber preformed flexible sections

- Reference Y50.2140A

- Vapour barrier permeance
  - Reference Y50.2170

- Vapour barrier coatings
  - Bitumen - reference Y50.2180A
  - Vinyl - reference Y50.2180B
  - Solvent polymers- reference Y50.2180C
  - Bitumen emulsion- reference Y50.2180D

- Adhesives - reference Y50.2190
- Protection
  - Self-adhesive multi-layer laminate covering - reference Y50.2200A
  - Roofing felt - reference Y50.2200B
  - Flat aluminium-zinc coated steel - reference Y50.2200C
  - Ribbed aluminium-zinc coated steel - reference Y50.2200D
  - Aluminium sheeting - reference Y50.2200E
  - Canvas - reference Y50.2200G
  - Canvas with aluminium bands - reference Y50.2200H

- Reinforcement - Reference Y50.2210#
- Valve and flange insulation
- Thickness table
  - Insulation thickness calculation methods, ECA Enhanced - reference Y50.2287
  - Insulation thickness tables - reference Y50.2289
  - Non-domestic hot water supply services, ECA Enhanced maximum permitted heat losses - reference Y50.2307
  - Domestic central hot water systems, ECA Enhanced maximum permitted heat losses - reference Y50.2331

250.080 THERMAL INSULATION - PLANT:

- Materials
- Thermal conductivity - reference Y50.2010
- Thermal performance life expectancy
  - For plant design life - reference Y50.2015A
  - Details - reference Y50.2015B

- Restrictions on use of materials - reference Y50.2020
- Mineral fibre insulation for hot water storage vessels
  - Resin bonded slabs

- Closed cell rigid phenolic foam (PF) slab
  - Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.
  - Foil faced - reference Y50.2120A
  - Reference Y50.2120B

- High density phenolic pipe support foam
    - Reference Y50.2130A
    - Obtain written confirmation from the manufacturer that the material is CFC and HCFC free.
- Closed cell nitrile and EPDM rubber elastomeric sheet and preformed sections.
    - Reference Y50.2140A
- Vapour barrier coatings
    - Bitumen - reference Y50.2180A
    - Vinyl - reference Y50.2180B
    - Solvent polymers- reference Y50.2180C
    - Bitumen emulsion- reference Y50.2180D
- Adhesives - reference Y50.2190
- Protection
    - Self-adhesive multi-layer laminate covering - reference Y50.2200A
    - Roofing felt - reference Y50.2200B
    - Flat aluminium-zinc coated steel - reference Y50.2200C
    - Ribbed aluminium-zinc coated steel - reference Y50.2200D
    - Aluminium sheeting - reference Y50.2200E
    - Canvas - reference Y50.2200G
    - Canvas with aluminium bands - reference Y50.2200H
- Reinforcement - Reference Y50.2210#
- Protection for heat exchangers and other vessels
    - Aluminium
        - Reference Y50.2230A
        - With chest covers - reference Y50.2230B
        - Aluminium-zinc coated steel
    - Multi-layer laminate - reference Y50.2230E
- Supply cylinder jackets
- Pumps and other irregular shapes - reference Y50.2280
- Thickness of insulation
    - Unless specified otherwise elsewhere, the thicknesses for flat surfaces or irregular shaped plant items shall not be less than that for the largest pipe size given in the thickness tables below
    - Insulation thickness tables - reference Y50.2289
    - Non-domestic hot water supply services (Building Regulations)
        - Rock mineral wool - reference Y50.2290
        - Glass mineral wool - reference Y50.2295
    - Domestic hot water systems, Building Regulations (rock mineral wool) - reference Y50.2330
    - Nitrile rubber - reference Y50.2440

- Thickness of insulation to BS 5422 for process pipework and equipment- reference Y50.2490#.

250.090 WORKMANSHIP PIPEWORK INSULATION:

- General - reference Y50.3010
- Installation of foil faced phenolic foam insulation - reference Y50.3030
- Installation of closed cell nitrile rubber insulation - reference Y50.3050
- Installation of protection
    - Polyisobutylene (PIB) - reference Y50.3120
    - Self-adhesive multi-layer laminate covering - reference Y50.3125
    - Sheet metal finish
        - Reference Y50.3130A
    - Canvas - reference Y50.3150
    - Roofing felt - reference Y50.3160
    - Aluminium sheeting - reference Y50.3170
    - Aluminium-zinc coated steel - reference Y50.3180
    - Rigid PVC - reference Y50.3190
- Flanges and valves - reference Y50.3210
- Installation where insulation is carried through pipeline support
    - Reference Y50.3230A
    - Closed cell insulation - reference Y50.3230B
- Liquid vapour barriers - reference Y50.3260
- Integrity of vapour barriers - reference Y50.3270

250.110 WORKMANSHIP EQUIPMENT INSULATION:

- General - reference Y50.3010
- Installation of insulation on tanks - reference Y50.3090
- Installation of mineral wool insulation on vessels - reference Y50.3100
- Installation of phenolic foam insulation on vessels - reference Y50.3110
- Installation of protection
    - Polyisobutylene (PIB) - reference Y50.3120
    - Self-adhesive multi-layer laminate covering - reference Y50.3125
    - Sheet metal finish
        - Reference Y50.3140A
    - Canvas - reference Y50.3150
    - Roofing felt - reference Y50.3160
    - Aluminium sheeting - reference Y50.3170
    - Aluminium-zinc coated steel - reference Y50.3180
    - Rigid PVC - reference Y50.3190
- Liquid vapour barriers - reference Y50.3260
- Integrity of vapour barriers - reference Y50.3270

Z251 - TESTING AND COMMISSIONING OF MECHANICAL SERVICES

251.010 GENERAL:

- The specifications of this section applies to HVAC, plumbing, and firefighting works.

251.020 SPECIALIST:

- Use a commissioning specialist who is a member of The Commissioning Specialists Association (CSA).
- Or approved equivalent

251.030 STATIC TESTING:

- Carry out air pressure and leakage testing on air ductwork in accordance with specification section covering air ductlines and ancillaries.
- Carry out pressure / leakage testing of builders work air shafts, voids and floor plenums where they are used for supply ventilation - reference Y51.2015
- Pressure testing
    - General - reference Y51.2010
    - Hot and cold water supply systems, water circulating systems (LTHW, MTHW, HTHW, chilled and condenser water) and steam and condense lines - reference Y51.2020
    - Underground pipework
        - Reference Y51.2030#
        - Test pre-insulated bonded steel pipe systems for district heating in accordance with BS EN 13941.
        - Test pre-insulated non bonded pipe systems in accordance with the system manufacturer's recommendations.
        - Test pre-insulated bonded flexible pipe systems in accordance with the system manufacturer's recommendations.
    - Underground cold water supply mains - reference Y51.2040
    - Fire risers - reference Y51.2050
    - Refrigerant pipework
        - Strength pressure test
        - Leak test
        - Deep vacuum test
        - Reference Y51.2055#
    - Oil pipework - reference Y51.2065
    - Condense and overflow systems - reference Y51.2075
    - Soil, waste, ventilation, anti-syphon and rainwater pipework - reference Y51.2080
    - Underslab drainage - reference Y51.2090
- Vacuum testing - reference Y51.2100
- Provide an air compressor and subject the pipework to sectional testing by air at low pressure (not exceeding 0.5 bars) before commencing any flushing or testing with water.
- On completion of all cleaning, flushing and air testing operations, recharge each system with clean water and subject them to sectional hydraulic tests of one and a half times the working pressure.

- There is to be no loss of pressure for a period of not less than 30 minutes for each test.

251.040 COMMISSIONING:

- Commissioning codes - reference Y51.3020
- Commissioning
    - Water distribution
        - Including BSRIA pre-commissioning check list
        - Reference Y51.3030
    - Air distribution
        - Including BSRIA pre-commissioning check list
        - Reference Y51.3040
    - Boiler plant - reference Y51.3050
    - Gas plant and systems - reference Y51.3055
    - Refrigerating systems - reference Y51.3060
    - Automatic control systems - reference Y51.3070
- Instruments and gauges
    - Reference Y51.3090A
- Commissioning records
    - For air systems
        - To BSRIA Guide BG 49/2015 - reference Y51.3100A
    - For water systems
        - To BSRIA Guide BG 2/2010 - reference Y51.3100B
- BMS commissioning
    - Control system specification details required for commissioning - reference Y51.3110
    - Pre-commissioning - reference Y51.3120
    - Plant ready for control system commissioning
        - Reference Y51.3130A
    - Control system requirements for plant commissioning - reference Y51.3140
    - Commissioning of building services as required by ADL2 (Section 5.16-5.28).
    - Commissioning of building services as required by Scottish Technical Handbook Section 6.7.
    - Commissioning - reference Y51.3150

251.042 SEASONAL COMMISSIONING:

- Seasonal commissioning - reference Y51.3025
- The seasonal commissioning shall prove that the operating performance of the following building services systems and associated equipment is as specified
- Commissioning codes - reference Y51.3020
- Work to be completed over a minimum 12 month period after building occupation
    - Testing of services under full load conditions
    - Re-commissioning of systems after any work needed to serve revised loads

- Updating of record documentation

251.050 PERFORMANCE TESTING:

- System performance testing - reference Y51.4010
- Testing of residential ventilation systems - reference Y51.4015
- Specific Fan Power Validation tests (SFPv)
    - After fitting clean filters, air handling systems to be commissioned under validation load conditions in accordance with Annex D in BS EN 13779. Measure the specific fan power SFPv of each system for calculation of the building "as constructed" CO_2 emission rate.
- Environmental tests for HVAC systems
    - Artificial loads - reference Y51.4020A
    - Ambient Air Quality - reference Y51.4020B
- Recorders - reference Y51.4030
- Testing to specified conditions - other systems
    - Rainwater Systems
        - Demonstrate by flow tests that the systems give satisfactory performance.
    - Sanitary Systems
        - Comply with performance tests given in BS EN 12056.
    - Hot and Cold Water Systems
        - Demonstrate that outlets supply adequate rates of flow.
        - Demonstrate that the hot water temperature at each outlet reaches designed temperature within one minute of turning on the tap.
        - In installations where the HWS return is local to the outlet, demonstrate that the hot water temperature at each outlet reaches designed temperature in less than 30 seconds.
    - Fire Fighting and Smoke / Heat Control Systems
        - Comply with requirements of the local Fire Authority, with the appropriate sections of BS 9999 and BS 9990 and the appropriate systems standards detailed elsewhere in this specification.
    - Acoustic Treatment
        - Demonstrate by measured tests that noise criteria indicated have been achieved.

Z252 - VIBRATION ISOLATION MOUNTINGS

252.010 GENERAL:

- The specifications of this section applies to HVAC, plumbing, and firefighting works.
- Comply with work section general clauses below
    - Design intent - reference Y52.1010
    - Spring anti vibration mountings - reference Y52.1020
    - Locking facility - reference Y52.1040

252.020 MAT AND PAD MOUNTINGS:

- Configured mat mountings
    - Neoprene/composite fibre/synthetic rubber
        - Reference Y52.2010A
    - Natural rubber - reference Y52.2010B
    - High temperature synthetic rubber
        - Reference Y52.2010C
- Resilient mat mountings
    - Cast in base - reference Y52.2010D
- Pad mountings
    - Composite synthetic rubber - reference Y52.2010E

252.030 MOUNTINGS:

- Turret compression mountings
    - Synthetic rubber - reference Y52.2020A
        - Lockable facility - reference Y52.1040
    - Neoprene - reference Y52.2020B
        - Lockable facility - reference Y52.1040
- Spring compression mountings - reference Y52.2030
    - Lockable facility - reference Y52.1040
- Captive spring mountings - reference Y52.2040

252.040 EQUIPMENT HANGINGS:

- Turret compression hangers
- Spring compression hangers - reference Y52.2060
    - Lockable facility - reference Y52.1040
- Combined turret/spring compression hangers
    - Synthetic rubber - reference Y52.2070A
        - Lockable facility - reference Y52.1040
- Neoprene - reference Y52.2070B
    - Lockable facility - reference Y52.1040

252.050 PIPEWORK HANGERS:

- Turret compression hangersProvide turret compression hangers fabricated from
    - Synthetic rubber incorporated with hanger box.
    - Neoprene incorporated within hanger box.
    - Reference Y52.2050#
- Spring compression hangers - reference Y52.2060
    - Lockable facility - reference Y52.1040
- Combined turret/spring compression hangers
    - Synthetic rubber - reference Y52.2070A
        - Lockable facility - reference Y52.1040
- Neoprene - reference Y52.2070B
    - Lockable facility - reference Y52.1040

252.060 HORIZONTALLY RESTRAINED SPRING MOUNTINGS:

- Horizontally restrained spring mountings
    - Reference Y52.2080
    - Lockable facility - reference Y52.1040

252.070 INERTIA BASES:

- Reinforced concrete - reference Y52.2090A
    - Lockable facility - reference Y52.1040
- Welded steel frame - reference Y52.2090B
    - Lockable facility - reference Y52.1040

252.080 VIBRATION ISOLATION HOSES:

- Vibration isolation hoses - reference Y52.2100

252.090 PIPEWORK NOISE VIBRATION ISOLATION:

- Natural corkwood - reference Y52.2110A
- Reconstituted corkwood granules - reference Y52.2110B
- Rubber matting - reference Y52.2110C

252.100 WORKMANSHIP:

- Horizontally restrained spring mountings - reference Y52.3040

252.110 PIPE, WALL AND RISER SEALS:

- Sponge foam packing - reference Y52.2120A
- Mineral fibre packing - reference Y52.2120B

Z254 - IDENTIFICATION MECHANICAL

254.010 GENERAL:

- The specifications of this section applies to HVAC, plumbing, and firefighting works.
- Comply with work section general clauses below
    - Requirements - reference Y54.1010
    - New systems - reference Y54.1020
    - Existing systems - reference Y54.1030
    - Colours - reference Y54.1040
    - Performance and durability - reference Y54.1045

254.020 PIPEWORK IDENTIFICATION:

- Reference Y54.2010

254.030 DUCTWORK IDENTIFICATION:

- Reference Y54.2020

254.040 PLANT AND EQUIPMENT IDENTIFICATION:

- Lettering
    - Engraved plates filled with paint
    - Laminated plates, multi-coloured with outer layer removed for lettering
    - Clear perspex back filled to reveal lettering
- Reference Y54.2030#

254.045 GRAPHICAL SYMBOLS FOR USE ON EQUIPMENT IN ACCORDANCE WITH BS EN 80416:

- Reference Y54.2035

254.050 VALVE AND COCK IDENTIFICATION:

- Reference Y54.2040

254.080 AIR VOLUME REGULATING AND CONTROL DAMPER IDENTIFICATION:

- Reference Y54.2070

254.090 INSTRUMENT IDENTIFICATION:

- Reference Y54.2080

254.100 DANGER AND WARNING NOTICES:

- Reference Y54.2090

254.110 SYSTEM IDENTIFICATION INSTALLATION CHARTS:

- Perspex sheet glazing with frame
- Hardboard in hardwood frame and glazed
- Plastic encapsulated chart
- Reference Y54.2100#

Z290 - FIXING TO BUILDING FABRIC

290.010 GENERAL:

- The specifications of this section applies to HVAC, plumbing, and firefighting works.
- Comply with work section general clauses below
    - Preparation - reference Y90.1010
    - Manufacturer's drawings - reference Y90.1020
    - Fixings - reference Y90.1030
    - Loading details - reference Y90.1040
    - Building-in by others - reference Y90.1050
    - Size of fixing - reference Y90.1060
    - Greasing of fixings - reference Y90.1070

290.020 FIXINGS:

- Standards - reference Y90.2010
- Plugs - reference Y90.2020
- Screws - reference Y90.2030
- Non-penetrative support systems - reference Y90.2080

290.030 WORKMANSHIP:

- Drilling - reference Y90.3010
- Fixing to timber rails - reference Y90.3050
- Fixing to hollow stud/tile/block wall
    - Reference Y90.3060A
- Fixing to concrete, brickwork or blockwork
    - Reference Y90.3070A
- Fixing to metalwork
    - Reference Y90.3080A
- Fixing to structural steelwork and concrete structures
    - Reference Y90.3090A

Z291 - OFF-SITE PAINTING AND ANTI-CORROSION TREATMENT

291.010 GENERAL

- The specifications of this section applies to HVAC, plumbing, and firefighting works.
- Comply with work section general clauses below
    - General requirements - reference Y91.1010
    - Damaged finishes - reference Y91.1020

291.020 PAINT MATERIALS:

- Paint materials
    - Reference Y91.2010A
- Paint quality - reference Y91.2020

291.030 WORKMANSHIP

- Weather and other conditions - reference Y91.3020
- Cleaning and preparing for painting
    - Steel surfaces - reference Y91.3030A
    - Surfaces - reference Y91.3030B
    - Reference Y91.3030#
- Application off-site - reference Y91.3040
- Application - reference Y91.3050
- Cold galvanizing - reference Y91.3060
- Protection of bright machine parts - reference Y91.3070

Z305 - BAGGAGE HANDLING SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions of Contract and Division 1 Specification Sections, apply to this Section.

1.2 CODES AND STANDARDS

A. ICAO:

- Annex 17th – 9th edition March 2011 – security – Safeguarding International Civil Aviation against Acts of Unlawful Interference.

B. IATA:

- Airport Handling Manual (16th edition);
- Airport Development Reference Manual (9th edition);

C. Electrical and Communication

- IEC: International Electro technical commission
- NETA: the international electrical testing association
- IEE: Institute of electrical engineers

D. Fire protection:

- NFPA 1 Fire protection code
- NFPA 13 Standard installation if sprinkler systems
- NFPA 70 National electrical code
- NFPA 80 Standard for fire doors and fire windows
- NFPA 80A Recommended practice for protection for buildings from exterior fire exposure
- NFPA 101 Life safety code
- NFPA 220 Standard on types of building construction
- NFPA 221 Standard for fire walls and fire barrier walls

E. Quality Assurance / quality control

- ISO 9000-3:1997 Quality management and quality assurance standards -- Part 3: Guidelines for the application of ISO 9001:1994 to the development, supply, installation and maintenance of computer software

- ISO 9001-2000: Quality management Principles

- ISO 10005:1995 Quality management - Guidelines for quality plans

- ISO 373 6- 19799 part 6: Biological evaluation of medical devices — Part 6: Tests for local effects after implantation

- ISO 10006:1997 Quality management - Guidelines to quality in project management

- ISO 10007:1995 Quality management - Guidelines for configuration management

- ISO/IEC 6592:2000 Information technology - Guidelines for the documentation of computer-based application systems

- ISO/IEC 13236:1998 Information technology - Quality of service: Framework

- ISO/IEC TR 13243:1999 Information technology - Quality of service - Guide to methods and mechanisms

F. Network Cabling

- TIA/EIA-568-B.1 Commercial Building Telecommunications Cabling Standard – Part 1: General Requirement

- TIA/EIA-568-B.2 Commercial Building Telecommunications Cabling Standard – Part 2: Balanced Twisted Pair Cabling Components

- TIA/EIA-568-B.3 Optical Fiber Cabling Components Standard

1.3 GLOSSARY OF TERMINOLOGY

BHIS: Baggage Handling Information System

BHS Baggage Handling System

BMA Baggage Management Array CBRA

Checked Baggage Resolution Area

CI Check In

ECAC European Civil Aviation Conference EDS

Explosives Detection System

ETD Explosives Trace Detection EU

European

F&B First and Business

FAS Fire Alarm System

HBS Hold Baggage Screening

IATA International Air Transport Association ICAO

International Civil Aviation Organization IG

In Gauge

O&M Operations and Maintenance

OOG Out Of Gauge

PAX Passenger

QA Quality Assurance

RFID Radio Frequency Identification

TSA Transportation Security Administration ULD

Unit Load Device

US United States

PART 2 - SCOPE OF WORKS

1. The scope of works includes all aspects of the checking the design, as necessary, manufacture, installation, all controls including hardware and software for the proposed system, testing and commissioning of the Departures, of BHS after obtaining the approval of the Engineer in case any modifications of the design.
2. The works are to include for the supply and installation of the following but not limited to:
    a. Weighing, Labeling
    b. Collector and Transport conveyors
    c. Steel Work and structure.
    d. Circulation support equipment such as dolly circulation ground marking (painting), signpost (equipment identification) and metallic protection (of

concrete column, concrete wall and equipment dimensioned to take impact loads from tugs and dollies.

e. Baggage Screening Site Cabling and trucking.
f. Laptop to be used for maintenance.
g. BHS system shall include integration to the general airport information systems (Common Use Passenger Processing and Airport Operations Database, Baggage Screening machine, Fire Alarm System (FAS), and all the required interface for the proper functioning of the system.
h. PLC control cabinets.
i. Field devices and Emergency Stop Switches.
j. Spare Parts for one-year operation are to be included under the scope of supply of this scope of work.
k. All accessories and components which are not listed above but necessary for the safe and satisfactory operation of the system.
l. Site tests and commissioning.
m. Functional specifications, O&M manuals, record drawings of all works.
n. The Baggage Handling System (BHS) package is made up of all the conveyors, automation and data processing equipment and the procedures allowing the automatic transport of bags from their input into the system to their output.

3. All equipment used for the baggage handling system must be proven design, and must be of the latest technology used successfully for a minimum period of one year in a comparable environment.
4. All equipment shall be suitable for operation 24 hours a day, 365 days a year, in the arduous duty of a regional Airport.
5. Safety, Availability, Reliability and Maintainability shall be to the highest standard and the Contractor may be requested to demonstrate these features of the equipment offered.
6. Coordinate with the company that will supply and install the EDS Hold Baggage Screening machines to ensure that the entire system will work as one unit. Coordinate the capacity of the PLC, MIS and the Operator Center Control.
7. Originating Process includes an explosives detection process, and shall therefore include additional equipment for security conveying, data processing and procedures allowing the implementation of this process. This process makes it possible to control 100% of hold baggage conveyed by the system.

PART 3 - SYSTEM DESCRIPTION

3.1 GENERAL DESCRIPTION

A. The following is a performance specification of the operation of the Baggage Handling System and is intended to serve as a guideline to highlight features which are required in the upgrade of such a system. Actual extent of works is to be decided by the Contractor's design after obtaining the approval of the Engineer.

B. Bag profile:

1. Hold Bags. The hold bags are divided into two subcategories:

a. In-gauge (IG) baggage: Baggage that is able to be fully handled by the baggage handling system, included security aspects.

b. Out of Gauge (OOG) baggage: Baggage for which at least one manual operation is performed.

C. Bag dimensions: The dimension of the hold baggage in upright-position shall be as per the table below:

Baggage Type	Length (mm)	Width (mm)	Height (mm)	Weight (kg)
Maximum "In Gauge" baggage size (mm)	900	300	750	60
Maximum "Out of Gauge" baggage size (mm)*	2500	600	1500	70

** Sum of all dimensions of OOG shall be less than 3000 mm (to be verified by the Contractor based on his equipment)*

*** Maximum conveyable baggage size is determined by the screening machine tunnel aperture, i.e. in the upright position, the maximum conveyable bag sizes are defined to be: Length: 900 mm Width: 700 mm Height: 900mm.*

D. System Description:
For the BHS system description, refer to document [Concept Design Report, KE26040-0101D-RPT-PM-01]

3.2 DESIGN PARAMETERS

A. Finishes will be selected to prevent damage from all possible combinations of atmospheric deterioration, corrosion, mould and pollution, and shall in no way be a potential health hazard to manufacturers, installers or operators. Material certificates will be requested as part of the Contractor's internal QA system.

B. Paint finishes will be powder coated, but exposed steel materials in public areas will be stainless steel of appropriate quality and surface finish. Other methods than powder coated are acceptable, but subject to approval of Contractors alternative painting specification by the Engineer.

C. Where materials are proposed by the Contractor, they shall not in any way be a potential hazard to health and the environment. The Contractor shall be deemed to have a full up-to-date knowledge of all current published research and legislation in this respect.

D. The Contractor shall warrant that none of the following will be used in the construction and manufacturing process:

1. Asbestos or asbestos-containing products.
2. Lead where the metal or its corrosive products may be directly ingested, inhaled or absorbed
3. Lead based paints and primers
4. Urea formaldehyde in quantities which may be hazardous or an irritant.
5. Materials which are generally comprised of mineral fibers, either man-made or naturally occurring, which have a diameter of 3 microns or less or which contain any fibers which are not sealed, encapsulated, or otherwise stabilized to ensure that fiber migration prevented.
6. Other substances generally known to be deleterious at the time of use.
7. Species of tropical hardwood, unless obtained from sustainable sources.

8. Chlorofluorocarbons (CFC) or any goods and materials containing the same.

E. All equipment placed by the Contractor as well as apparatus, materials and accessories used in the BHS installations shall be capable of a normal operation under the climatic conditions found in CBHS:

1. Temperature:

a.	Maximum outdoor temperature:	38ºC
b.	Minimum outdoor temperature:	15ºC

F. Contractor shall pay particular attention to air humidity, not only in open-air area but also in non-air-conditioned rooms. Materials for any part of the system shall be chosen in accordance. Implanted close to outdoor, the BHS electromechanical equipment at the new BHS building (ground floor) could be affected by above mentioned climatic conditions.

G. Running schedule: The baggage processing facility can be operated 24 hours every day of the year. Depending on the operation rate, maintenance may be performed while the system is running.

H. Noise Level: The proposed system shall be designed and installed so as to avoid the generation of acoustic noise levels that are unlawful or harmful to personnel. Noise levels at 1 m from any part of the equipment shall not exceed 75dB (A) in the Baggage hall and 65dB (A) in the Public Areas under the following circumstances. Noise measurements shall be done based on the principles described in ISO 373 6- 19799 part 6. The integration of the measurements results shall cover a time period of 15 minutes.

1. Absence of warning sounders.
2. Only that part of the system is in operation.
3. System is loaded with baggage.
4. That part of the equipment is operating at its design capacity (speed).

I. Design Loads of conveyors:

1. Continuous Load Capacity not less than 100 Kg/m.
2. Max Load 150 Kg/m
3. Conveyors shall be capable of starting under full design static load conditions.
4. Capacity: 1,200 bags/hour.

J. Bag Jam Rate Requirements:

1. The maximum acceptable bag jam event rate is 1/1000. This is calculated by taking the total number of bag jam events divided by the total number of bags in a 24-hour period.
2. No more than three bags shall be involved in any given bag jam event.

K. Tracking accuracy:

1. Tracking accuracy shall be maintained at a minimum of 99.5 percent where baggage tracking is required. This percentage will be calculated using the total number of bags inputted into the baggage system on a monthly basis.

L. Lifetime Constraints

1. Additional BHS components' lifetime: 15 years
2. Service lifetime: The service life required of the equipment is:
    a. 10 years for electromechanical equipment.
    b. 5 years for data processing equipment.
3. This service life does not apply to wearing parts (belt, drum, roller, etc.).
4. The equipment must retain their characteristics and performance throughout the agreed service life.

M. Wearing parts and spare parts

1. Wearing and rotating parts shall be designed for 24 hours/day, seven days/week, 52 weeks per annum at full load service without requiring excessive maintenance, repairs, work stoppages or direct operator supervision.
2. Wearing and rotating parts shall be designed for a minimum lifetime of 60,000 hours.
3. The equipment manufacturer shall submit warranty to ensure this required minimum lifetime of 60,000 hours. The warranty shall cover replacing any component or part that is faulty or defective at no cost to the client. Client shall not pay for shipping or handling, replaced parts shall be delivered to client store.
4. Standardization of the equipment components/parts (drum, bearing or other equipment) shall be considered.

3.3 SUBMITTALS

A. Compliance sheet to be filled in by the manufacturer of the BHS indicating the following data:

Description	Comply	Not Comply	Remarks
Item no.----			

B. Manufacturer's catalog data shall be submitted for the following items:

1. Equipment and Accessories
2. Spare Parts including parts numbers

C. Certificates of all equipment including country of origin shall be submitted for following items showing conformance with the referenced standards contained in this section:

D. Contractor shall identify critical long lead parts and shall provide cost, part number and delivery period.

E. Spare Parts list for parts needed for one-year operation are to be included under the scope of supply of this scope of work, the Contractor shall provide detail spare parts number including itemize cost. Without being limited to the following list, parts shall include:

1. Mechanical:
    a. motor reducers / electric motors
    b. bearings and bearing blocks
    c. belts- all types provided in system

d. return rollers

e. snub rollers

f. sprockets

g. drive drums and tensioning drums

h. head and tail pulleys

2. Electrical and PLC:

a. relays

b. contactors

c. thermic overloads

d. push buttons

e. emergency stops

f. Converters

g. Photo switches

h. Weighing scale elements

i. Input and output card

j. Main processor

k. Communication cables

F. Operating and Maintenance Manual: Operating and maintenance manuals shall be supplied with the installation (draft shall be submitted at least two months prior to testing and commissioning of the system, for review and approval by the engineer).

G. Manuals shall describe both operating and maintenance procedures and comprise detail information to operate, fault find and allow maintenance activities.

H. Manual shall include all maintenance detail activities and cycles for each component in the system.

I. Manual shall illustrate complete lists of the mechanical and electrical components applied in the installation with all relevant information with ordering references for replacement shall be included as well as a complete set of drawings and wiring diagrams.

J. Product information of sub-suppliers shall also be enclosed. Three hard and soft copies of each manual, written in English language, must be submitted before the completion of the total installation. Any modification to their contents required by the Engineer shall be incorporated.

K. Product Data: Equipment and Performance Data shall be submitted for all items as specified indicating use life, system functional flows, safety features, and other features such as electrical system protective device ratings.

L. Sample Warranty: Copy of manufacturer's proposed warranty, stating obligations, remedies, limitations, and exclusions.

M. Shop Drawings: Signed and sealed by a qualified professional engineer. Connection

diagrams shall be submitted indicating the relations and connections of all items. The drawings shall indicate the general physical layout of all controls items such as control cabinets, wiring details and control room layout.

1. Control cabinets: details such as size, location, Panel IP rating, Panel material, Panel color, internal components description and rating, etc.…

2. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

N. Coordination Drawings: Floor plans drawn to scale and coordinating the following:

1. Structural supports.

2. Wiring roughing-in requirements.

3. Determine spaces reserved for electrical equipment.

4. Access requirements around other work.

5. Required clearances for operation and maintenance.

O. The Contractor shall supply as built drawings hard and soft copy on completion of the installation. They shall include general layouts, "as finished" general arrangements and steelworks, platforms, etc.

P. Test Plan: The Contractor is to submit a detailed written Test Plan for review and approval by the Engineer prior to the start of any testing activities to include but not be limited to all static, functional, and integrated testing procedures required to assure a fully operational system.

Q. Tools: Submit a list of all special tools required to perform any kind of maintenance or repair. The list shall include part no, type and itemized price.

3.4 QUALITY ASSURANCE

A. Contractor must employ a Quality Management System complying with the program described in ISO 9001-2000, or similar system. This system shall comprise all the participants of the project within the Contractor's teams and subcontractors. The Quality Assurance Plan shall be based on the quality manuals of the Contractor and sub-Contractors.

B. The Contractor shall nominate from the beginning of the project the Quality Assurance Manager in charge of quality assurance of the whole project, who is directly linked to the Project Director.

C. The Contractor shall establish from the beginning of the project the Quality Assurance Plan based on Contractor's quality system that shall define:

1. The quality assurance plan of Contractor and Sub-Contractors considered during project life.

2. Management Master Plan:
   a. It is the leading document of the Quality Plan.
   b. It defines the organization and the list of procedures the Contractor intends to set in order to conduct the project.

D. Moreover, the Client may at his own will:

1. Inspect any of the Contractor or subcontractor facility,
2. Request any production document, as purchase order, material flow order, operation shop sheet, etc...
3. Attend any in-house test
4. Inspection of Contractor or subcontractor facility or test attendance shall be done by the Client representatives at Contractor expenses (air fares and daily allowances).

3.5 WARRANTY

A. Provide a written warranty signed by the system manufacturer and countersigned by Contractor, agreeing to furnish parts for motor failures within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion and issuance of taking over certificate.
2. During warranty period, the Contractor shall replace defective parts, with the exception of parts that are subject to normal wear.
3. All defective parts shall be supplied with no cost.

PART 4 - PRODUCTS

4.1 STANDARD COMMERCIAL PRODUCTS

A. Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship.

B. The standard products shall have been in satisfactory commercial or industrial use for 5 years prior to bid opening.

The 5-year use shall include applications of equipment and materials under similar circumstances and of similar size. The 5-year experience shall be satisfactorily completed by a product that has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 5-year field service record shall not be acceptable. System components shall be environmentally suitable for the indicated locations.

SECURITY CONSIDERATIONS

GENERAL: In line with the ICAO directives, 100% of hold baggage on outgoing flights shall be inspected to prevent explosive devices to be taken onboard. All originating and transfer baggage must be screened. This inspection process should achieve the best compromise between operating constraints (minimizing handling time, matching the throughput needed by large number of bags) and security constraints (quality of the detection process for explosives) and in the most economical way possible.

The originating BHS incorporates Hold Baggage Screening devices, making it possible to screen 100% of baggage carried by the system for departure baggage.

The security procedure for IG baggage defined is based on the principle of successive baggage inspections by Conventional CT (Computer tomography) and then by ETD equipment for un-cleared bags.

OOG baggage is sent first to screening machine and then to ETD machine and then they are opened and physically inspected in the presence of the passenger.

Contractor shall coordinate with security and screening system supplier regarding all screening units, conveyor belt integration and system interfaces.

PRODUCTS

STANDARD COMMERCIAL PRODUCTS

Materials and equipment shall be standard products of a manufacturer regularly engaged in the manufacturing of such products, which are of a similar material, design and workmanship. The standard products shall have been in satisfactory commercial or industrial use for 5 years prior to bid opening. The 5-year use shall include applications of equipment and materials under similar circumstances and of similar size. The 5-year experience shall be satisfactorily completed by a product that has been sold or is offered for sale on the commercial market through advertisements, manufacturer's catalogs, or brochures. Products having less than a 5-year field service record shall not be acceptable. System components shall be environmentally suitable for the indicated locations.

GENERAL

The following is a complete specification for the major equipment and material. Final products and all equipment and accessories necessary to achieve the layout are to be as per manufacturer’s recommendations.

All below equipment are specified for Baggage Handling System

The following is a main specification for the major equipment and material:

Finish: Where a stainless-steel finish is requested it is to be, as a minimum, a 320 Grit polish with a 2B finish. Where a painted mild steel finish is requested it is to be an epoxy resin powder coating, galvanized sheet.

1. Drive Motor: One manufacturer is to be used for all conveyors and sorter drive motors installations.

2. Drive Drum: One manufacturer is to be used for all conveyors and machine drive drums.

3. Bearings: One manufacturer is to be used for installations.

4. Belting: All belts are to have vulcanized endless joints. All belting is to be Fire Retardant to ISO 340 or equivalent. Belting is to be supplied by one supplier.

5. Pulleys: Pulley diameters quoted are minimum dimensions. Collect/Transport Conveyor pulleys with more than 45-50 mm of belt wrap are to be fitted with external bearings.

MOTORIZED CONVEYORS REQUIREMENTS

Motorization system:

A friction drive unit to engage and drive the carrier chain unit. A SEW motor reducer of a worm gear type with a hollow shaft shall be directly fitted onto the drive shaft. An electrical soft start unit shall be included. Motor power to be selected in accordance with the length.

CONVEYING BELTS

Generalities: Items involved in present specification are the following

- Check-in belts,
- Conveying belts, which may be flat or slightly sloping,
- Flat curved belts,
- Description of components: Main technical characteristics are the following

Resistance to fire: According to EN 20340 (ISO 340),

Structure:

2 plies polyester fabric, with a woof being transversally rigid for check-in belts, for conveying belts - inclined or not - and for belts that stand transversal stress (e.g. take-away conveyors),

2 plies polyester fabric, transversally flexible, for curved conveyors, being helical or not,

Top Smooth surface: 0.5 to 1.2 mm of black hard PVC;

Top Gripping surface: 1.5 to 3.2 mm of black PVC;

Bottom side:

Soundproof; friction coefficient on steel slider bed0.2 to 0.3; equipped - if necessary - with two guidance lateral trapezoidal sections,

Total thickness: 2.4 to 9 mm (without possible guidance sections),

Electrostatic characteristics: anti-static.

Design and measurement rules of conveying belts

Generalities

The joining of belts must absolutely not be executed using hooking system, except in case of rapid replacement of a strip under working.

Both external developed lengths of each edge shall be identical.

Belts for curved conveyors, being helical or not

The bearing face is equipped with a flange, placed on the side of external diameter, in order to prevent the risks of jamming which may be caused by the space existing between belt and sidewall bottom

4.2 CONVEYORS SUPPORTS

A. Conveyors resting upon the ground

1. Conveyors are supported with trestles equipped with bracing or metallic stands (depending on height), the lower portion of them including height-position adjustment-jacks, equipped with anti-skidding pads.

2. The upper portion of trestles or metallic stands is fixed on the conveyor structure with silent blocks. These silent blocks may be insulation-mounted between the ground and the trestles or metallic stands.

3. The fixed portion of ground-conveyors supporting systems can be possibly fixed with auto-drilling or chemical pins (to be determined with the Client).

4. In case of conveyors resting upon a metal floor, each supporting system is underpinned with a whole metallic set equipped with adjustment-jacks, so that loads and points of supports can be distributed over floor beams and joists, if necessary. The fixing method applied to the fixed portion of supporting systems shall be adapted to the nature of the ground.

B. Design and measurement rules

1. Check-in conveyors frames and roller-paths shall be calculated so that they can support the loads of all the conveyors and loads resulting from working operations.

2. Elements of supporting systems are to be calculated by the Contractor, according to rules of measurements (loads to be supported) as defined below:

   a. Weight of the structure of each conveyor or each conveying mechanism,

   b. Dynamic moving stress carried out by the belt or conveying mechanism, once loaded (baggage and possible supports),

   c. Weight of a man: 80 kg

   d. Weight of maintenance tooling (e.g. sticking of belt),

   e. Load of baggage increased with the weight of handling supports, for every lineal meter, depending on conveying technologies applied. In case of crude conveying, the load to be considered is 100 kg for one lineal meter.

3. The supporting method (hanger tie rods, stands, cross-bars, intermediate supports etc.) applied to conveyors must allow the dismounting of principal components without being forced to remove the conveyors themselves.

4. Supporting methods implemented have to:

   a. Allow conveyors to be isolated from building structures or steel frameworks,

   b. Prevent vibrations coming from conveyors from being transmitted to building structures or steel frameworks.

5. Bolt-and-nut works have to be carefully locked after adjustment operations.

6. CIRCULATION SUPPORT EQUIPMENT

a. Dolly circulation ground marking (painting), signpost (equipment identification) shall be durable and resistant to dirt and dust.

b. Metallic protection of concrete column, concrete wall and equipment shall be shock resistant. For instance, column protection shall be able to support the shock of a typical full dolly traveling at its maximum speed.

4.3 Tilt Tray Sorter

The TTS track shall be completely level without any incline or declines.
The TTS layout shall conform to the manufacturers' recommended design parameters.

All TTS inductions shall consist of a 30 Degree Induction unit with strip belts and 2 or more belt conveyors for spacing baggage

4.3.1 Specific Tilt Tray Sorter Performance Requirements

TTS shall have a minimum capacity of 90 bags/min along any point in the TTS. Each TTS is logically divided into 2 sorters each with 90 bags/min capacity. The logical sorters are defined as starting with a set of initial inductions (check-in or transfer inductions), screening discharges and re-inductions and ending with discharges to the conveyors leading to ICS loading.During testing, demonstrate the throughput along both logical sorters at the same time at 95% of the required rates for a 5-minute period out of a 30-minute period while the average for the 30-minute period shall be a minimum of 85% of the required rate. To demonstrate this during testing, the screening functions may be bypassed.

Limit bags loaded in tubs from all the input points and then become separated after a TTS discharge to 0.5% of the bags that are in tubs.

Where applicable, the HLC shall determine the sort destination based on the combined information obtained from the 90-degree under-belt barcode reader plus 270-degree over-sorter barcode reader. The final sort destination shall be decided after the result of the information obtained from the 270-degree over-sorter barcode reader consolidated with all previous barcode reads.

Provide TTS induction and discharge capacity in accordance with the following table.

Table 1: TTS Minimum Performance Requirements

ID	Sorter Induction Type	Required Induction Rate
1	Originating/Transfer	45 bpm or every second tray (whichever is greater)
2	Manual Encoding	30 bpm or every third tray (whichever is greater)
3	HBS Re-Induction	45 bpm or every second tray (whichever is greater)
4	Sorter Discharge Type	Required Discharge Rate
5	Untracked Discharge	Every second tray
6	Tracked Discharge	Every third tray

4.4 Automatic Tag Reader Read Rates

Achieve a minimum Successful Read Rates as indicated in the table below (with the exception of bags on which no machine-readable tag has been applied), including bags in which the machine-readable tag is present, but is unable to be read due to tag orientation. Mis-reads of baggage tag information shall not occur. Notify the Owner of any degradation of read rates due to poor quality of tags and provide clear evidence of such poor quality and that it is affecting read rates. Tag quality shall be considered acceptable unless and until evidence of poor-quality tags is provided to the Owner.

Table 2: Minimum Required Bag Tag Read Rates (Optical/Barcode)

Type of Tag	During Testing (%)	During Live Operations (%)
Optical Tag on Originating Baggage	98	95
Optical Tag on Transfer Baggage	98	95

During FAT, carry out testing with 3 different RF tag reader suppliers in an attempt to achieve a minimum 99% successful read rate. If the read rate on all three RF tag

readers is below 99%, the RF tag reader with the highest successful read rate during the testing shall be chosen for this Contract and the read rate proven during testing shall be maintained during SATs and live operations. Provide video recording and test results from 3 different RF suppliers.

Baggage Tracking and Encoding Rates

Track all outbound conveyors from the input locations (defined as check-in take-away and transfer input belts) to the discharge onto the make-up device.

The required tracking accuracy varies depending on the purpose of the tracking.

The purpose of tracking upstream of the security process is for data gathering purposes (processing times, throughput, etc.).

The purpose of tracking during the security process and up to and including the TTS and related manual encoding lines is for security and sortation purposes.

The purpose of tracking from the TTS discharge to the make-up device is for data gathering purposes.

Tracking accuracy shall be measured along the entire process of a bag, not on a Subsystem-by-Subsystem basis.

Table 3: Raw Bag Minimum Tracking Performance Requirements

Tracking Requirement	Mis-track Definition	Minimum Performance
Data Gathering	A bag has moved out of the tracking window	95%
Security Screening Decision Zones	A bag has moved from the tracking datum by an amount greater than 300mm, or less if required by local regulations.	99%
From ATR to Final Sortation Point	A bag has moved from the tracking datum by an amount greater than 300mm	99%

For calculation of processing times, assign bags that do not successfully track the average processing time of the bags that did track successfully and had to go to Level 3 screening and manual encode.

Bags proven (as reported by BHS O&M or BHS operations staff) to have lost tracking due to being incorrectly introduced into the BHS, for instance bags with wheels down or bags that are moved out a tracking window as a result of the clearance of a bag jam, shall not be counted against the tracking accuracy. Report these situations to the Owner and request approval to deduct them from the mis-tracked bags quantity.

BDD Sizing Performance Rates

The Baggage Dimensioning Device shall accurately size 99% of all items that pass through the array. Any item detected by the present photocell but not sized by the BDD shall be treated and acted upon as an out-of-gauge item by the BHS.

Sortation Accuracy

Sortation accuracy from an encoded position (ATR or MES) of 99.9998% shall be achieved for the total number of bags input into the BHS. Demonstrate sortation accuracy during SATs; maintain sortation accuracy during any operational trials.

Start-up and Recovery Times

The expected boot time from fully powered off condition shall be as identified below:

Table 4: BHS Boot Times

BHS Condition	Maximum Boot Time
No power to the complete BHS	5 minutes
Redundant server pair (master and standby server) from a power off condition.	5 minutes
Switchover in case of a server failure	3 minutes
Operator workstation	1 minute
Any PLC or LLC controller	30 seconds

The HLC servers shall respond to all real-time requests from other BHS equipment such as ATR, PLC and any other interfacing equipment within 900 ms of receiving the request.

Data in any BHS that contains bag information data (e.g., TTS controllers or) shall be reconciled to the HLC data at all times. If the connection to the HLC is broken, download the most recent bag information first from the external interface, then followed by older bag information once the connection is re-established. The data tables shall be reconciled within 2 minutes of the connection being re-established.

Damaged Bag Limit

During each calendar month of BHS O&M, the number of damaged bags shall not exceed 1 bag per 100,000 bags handled by the BHS. Only damage caused by the BHS shall be considered for the purposes of this clause. Prove to the Owner without any reasonable doubt if there are any damaged bags, which are deemed to not be due to BHS related problems.

Minimum Redundancy Requirements

General

Demonstrate through appropriate design submittals and during SAT that the BHS meets the minimum redundancy fallback requirements as described within the TS.

Processing Path Redundancy

Power redundant Subsystems from different building power sources such that a power failure of a single source does not reduce the BHS capacity by more than 50%.

Design BHS power distribution such that any single failure in the BHS power distribution does not reduce the BHS capacity by more than 50%.

Demonstrate the redundancy concept prior to finalization of the BHS design with drawings that identify the power distribution redundancy together with LLC redundancy and the layout (physical path) redundancy.

Low-Level Control System Redundancy

Provide PLCs in the following configurations:

Table 5: LLC Redundancy

Redundancy Configuration	Sub-Systems
Hot Back-up	• Each Safety PLC
Warm Back-up	• Any subsystem whose failure affects more than 25% of the capacity of the specific BHS function. • Each TTS - (1 PLC per TTS) • Complete Bag Store
Cold Back-up	• Each Arrivals sub-system - (1 PLC per subsystem) • Each OOG sub-system - (1 PLC per Subsystem)

Connect each PLC to two network switches such that a failure of any one network line or switch shall not affect the normal function of the BHS.

Do not control parallel Subsystems of the same function from the same PLC unless they are fed from or feed a single Subsystem.

Each PLC shall only control Subsystems connected to the same power source as defined in the TS such that a failure of a PLC would not cause more Subsystems within its control to be inoperable than a failure of a power source.

High Level Control System Redundancy

The entire HLC System shall be provided in warm back-up configuration.

The failure of primary redundant equipment shall not degrade the response time of the Control System. In the worst-case scenario where every piece of primary control equipment has failed, there shall be no impact on BHS performance whatever the combination of the failure and the BHS shall continue operating on the secondary control equipment.

The BHS shall reconfigure itself automatically after redundant hardware takes control (the secondary system shall become the primary; the failed system shall become the secondary when it comes back on-line). The switch over shall be fully automatic without need for any operator intervention for the reconfiguration. The BHS shall report any hardware failure, power failure,

communication loss, etc., raise a critical alarm and inform the maintenance personnel through both graphical and textual displays on SCADA.

Backup equipment where provided shall be used as redundant equipment. All hardware, software, networking, and architecture shall comply with the requirements of the redundant system. The back-up equipment shall not be used for normal production (e.g., load sharing/balancing).

4.5 CONTROLSYSTEM REQUIREMENT

A. General:

1. New control panels shall be added to control and monitor the new system. One control panel will be dedicated to the arrival system and one dedicated panel will be dedicated to the departure system.

2. The electrical control system shall be designed for maximum security, reliability and easy access for maintenance.

3. Energy Saving: considerable energy saving, extended mechanical lifetime as well as noise reduction shall be achieved by automatic controlled starting and stopping of groups of motors, individual motors and good system management. This shall be coordinated with the existing energy saving scheme used in the existing system. Energy saving shall be achieved by software that stops those conveyors that are not required to run because there is no baggage in that area.

4. Safety: Emergency stop facilities, emergency stop push buttons without key shall be provided next to the newly added equipment. The number of e-stops stations shall be dictated by the conveyor design (for example, there should be sufficient e-stops stations for a group of conveyors). Operation of an emergency stop shall be immediate in effect being hardwired into the equipment drive contactor circuits and must stop the complete system. Emergency stops shall be of the latch release type wired direct to the main panel. Emergency stop shall have priority over all other functions. The number of emergency stops shall be mentioned in the submittal for approval.

5. The control system shall be based on the use of PLC systems.

6. The chosen PLC system shall provide support for a communication network in order to permit inter-PLC communication if required and communication between the control PLC systems and the SCADA Management Information System (MIS).

7. The Contractor shall ensure that all added control items related to PLC/SCADA system shall be supplied from Uninterruptible Power Supply (UPS)

8. The Contractor shall consider minimize the number of components used within the control system in order to reduce the required spares holding and maximize component inter-changeability.

B. Control System Architecture

1. The architecture of the control system in terms of the number of PLC systems that are proposed and the parts of the system that each control, shall be such that no single failure within a control system shall cause a system failure whose effect in throughput is greater than 50% can be caused by a single failure in the mechanical

sub system. each of the PLC cabinets, related to departure and arrival system shall consist of Hot Type Dual redundant PLC.

2. The controls architecture may be based upon centralized control and I/O or centralized control and distributed I/O at the discretion of the Contractor.

C. Deliverables

1. The architecture for the control system shall be detailed in the tenderers' response. This shall identify as a minimum the following: -

   a. Selected PLC Type
   b. Centralized/Distributed I/O configuration
   c. Communication network types and standards
   d. The number of PLC System proposed
   e. The mechanical equipment controlled by each PLC
   f. The redundancy philosophy employed to restrict failure effect.

2. A set of electrical drawings shall be included and shall consist of:
   a. Electrical layout showing all sensors, motors and terminal boxes
   b. Schematic diagrams
   c. List of all outgoing terminals
   d. Layout drawing of cabinets
   e. Layout drawing of control room
   f. Drawings of all terminal boxes

3. Functional Design Specification

   a. The Contractor shall produce a functional specification at the outset of the project using performance parameters and functions indicated in this specification. This description must include all proposed system functions including human machine interface screens, operational procedures, emergency procedures and all other aspects of the control systems, etc.… It shall also include the interface with the existing SCADA/PLC system including all required upgraded in the existing SCADA/PLC system.

   b. The Functional Design Specification (FDS) shall be approved by the customer considering that it remains the Contractor's responsibility that system meets the requirements.

4. Interface Control Documents

   a. The Contractor shall prepare interface control documents for all interfaces and obtain approvals/Sign-off from the interface system providers through the employer.

D. SCADA Management Information System (MIS)

1. The SCADA system shall be provided to perform the following functions:

   a. Display of the conveyor layout in an onscreen mimic using color change to represent the status of each item of equipment.
   b. Graphical displays shall be provided for an overview on which the whole system is visible on a single screen and detailed displays each showing parts of the system in sufficient detail to show all conveyors and associated device status. Equipment's interfaces status with SCADA should be shown i.e. (interface available, interface offline, etc…)

c. Display fault information in the form of color change of appropriate elements of graphical displays and as text messages indicating the equipment reference that the fault relates to and the nature of the fault and its occurrence time.

d. The 4 most recent faults should be shown on a banner at the bottom of each screen and a fault summary screen shall be provided which displays all active faults.

e. A historic faults screen shall be provided allowing the user to view all faults that have occurred over the past 24 hours.

f. Log statistical and fault data for use in reports such data should be held on disk for a minimum of the last complete calendar month. Statistics data shall be logged every hour; faults shall be logged on occurrence. Statistics shall log the parameter value against the time every hour; fault data logs shall include equipment reference, fault message occurrence clearance and duration times. The log file format should use Comma Separated Variable (CSV) or other format that can be easily loaded to an external package for analysis such as spreadsheet or database applications.

g. Performance report including as a minimum:

1) Throughput through each check-in desk
2) Throughput from each group of check-ins
3) System performance
4) Missed bag read at each stage
5) Record of each failure
6) Number of bags processed at each level of screening process
7) scanner performance (read/no read)

h. Performance report should use key performance indicators for performance analysis and optimization of baggage process. Measurement of KPIs such as Baggage entering the system and exiting for outbound baggage based on various criteria i.e. by flight, by Airline, By Sector, etc…. at any given duration of time as specified. KPI's shall include but not be limited to:

1) First bag / Last bag (integrated with FIDS for arrival PAX)
2) The journey time of every bag through the system including average processing time, average number of bags rejected at hold baggage screening levels.
3) Throughput of the line / hr
4) Bag tags read failure rate
5) % of OOG bags

i. Fault Report including as a minimum

1) Total Quantity of Faults
2) Total Duration of Faults
3) Top Ten Faults by total Fault Duration
4) Top Ten Faults by Number of occurrences of each fault

j. Reports shall be produced on demand for a time period selectable from a minimum of 1 hour to the maximum duration of the logged data.

k. A control screen to provide system start/stop and rote selection functions

l. The system should send alerts (faults and others as specified) to systems specified by the employer. Other alerts will be aiming at continuously improving your baggage operation

m. There should be clear separating of the reporting and analysis tasks from real time functions like sort control and baggage reconciliation

n. Centralized reporting facility, combining data from several sources to enrich the reports, allowing for analysis to stretch your systems operational ability.

o. Easy to use web-based interface with full flexibility to select intersections of information for better insight into and control of your baggage processes,

p. Enabling pro-active actions on facts instead of feelings

q. System should allow for baggage Process Trend Reports and for real- time trend analysis onscreen.

r. integrated security control, passenger profiling

s. optimization of resource usage reports

t. real-time information on system service levels

u. Performance statistics of the BHS processes including performance of screening

v. Proactive alerts for potential capacity, blockages and throughput thresholds

w. Analysis of system usage and performance by handlers and airlines

x. Proactive preventive maintenance alerts on devices and schedule tracking

y. Alerts and alarms distribution to Employer specified method such as mobile devices.

2. One laser printer shall be provided to enable statistical and fault reports to be printed.

3. The Systems disk shall be sized to ensure that the data volumes produced by the above requirements can be accommodated along with all operating software and a minimum 30% spare capacity. Moreover, storage capacity shall allow for a backup storage period of 2 years.

4. The system shall also provide a DVD+RW writer to allow large files to be extracted from the system in a means that can easily be loaded onto other computers.

5. The SCADA system shall support the chosen communication network for interface with the PLC systems.

6. It should be in contractor scope to review the BHS analysis report with the employer and verify the operational requirements. Contractor must then provide customized management report as per the requirements.

E. Control Panels

1. Control panels shall be provided to house all electrical equipment which requires control panel mounting including but not limited to:

a. PLC and I/O Hardware

b. Motor Control Equipment
c. Power Distribution
d. Emergency Stop Circuits
e. Combined thermal overload and short circuit protection switches
f. Main switches
g. Control relays
h. Power supply
i. Circuit breakers
j. Surge arrestors
k. Power, current and voltage monitoring devices
l. Protection devices
m. Lighting bulb
n. Thermostats/hygrostat
o. Fans/heater (as needed)

2. Control panels shall be built with sufficient spare room of at least 25% for future expansion. Control cabinet shall be constructed form sheet steel and finished in paint of color as per the Engineer's approval. IO spare shall ensure at least 25% spares for each type of IO.

3. All field wiring connections shall be made via terminals in the control panel.

4. Contractor to ensure that the PLC is furnished with a minimum of forty (40) percent spare control and data base processor memory.

5. Control panels shall provide door mounted controls for the following as a minimum:

   a. A panel mounted HMI (15" at least) shall be provided to indicate the operation status of the system
   b. Main door Interlocked Isolator
   c. System Enable
   d. Emergency Stop
   e. Fault Lamp with horn
   f. Control voltage on/off button + indication
   g. System on/off buttons + indication
   h. Emergency stop reset button
   i. Panels shall meet a minimum ingress protection rating of IP55 for indoor locations and IP65 (NEMA 4X) for outdoor locations. Panel construction shall be sturdy and suited to the environment.

6. Panels shall be fitted with fans/heaters connected to redundant thermostat/hygrostat to ensure equipment remains functional in the environmental conditions used for this project, same to be confirmed by cooling/heating calculation provided by the panel manufacturer
7. Motor Control

   a. Motor control circuits shall generally take the form of Direct On Line starters. Motors in excess of 4.0 kW in size shall be provided with soft start device.
   b. The Contractor shall determine and incorporate variable speed inverters drives as required by the equipment proposed and its application.
   c. All motor control circuits shall incorporate thermal and magnetic curve D circuit breakers that incorporate phase failure protection.
   d. The Contractor shall incorporate any electrically powered brake and or clutch

circuits as are required for proper operation of the equipment proposed and its application.

e. Motor control wiring shall be at least 2.5 mm2 rated 500 Volt.

f. Contractor shall consider reverse operation for reverse operated motors as mentioned in the drawings.

F. Field Devices

1. Field Devices such as photo electric cells proximity switches etc shall be selected to be suited the duty imposed on them by their application and should be included but not limited to:

   a. Local Motor Isolators
   b. Photo Electric Cells
   c. Emergency Stop Push-buttons
   d. Emergency Stop Tripwire Assemblies
   e. Photo electric cells
   f. Proximity switches
   g. Audible and visual alarm, etc….

2. Consideration shall be given to selecting devices so as to minimize the number of different parts and maximize the component inter-changeability.
3. Devices shall employ a plug-in type electrical connection to facilitate quick disconnection and re-connection.
4. Devices shall be securely mounted in a manner that will prevent accidental displacement or misalignment causing improper operation.
5. Devices shall be mounted so as not to cause an obstruction to baggage flow.
6. It is the Contractors responsibility to specify and provide all devices necessary for the correct operation of the system.

G. Manual Encoding Subsystem

1. General requirements:
   a. Manual encoding subsystems are secondary tag identification system providing a method to manually identify bags not properly identified by scanner arrays.
   b. The manual encoding subsystem shall consist of a small, MS Windows® based computer with a built-in monitor, a detached keyboard and a hand-held scan gun.
   c. The encode position shall include an optical tag printer for printing replacement tags as necessary.
   d. The hand-held scan gun is used with readable bar codes that were not successfully read by the scanner array.
   e. The manual encoding system shall be easily programmed and configured with clearly defined procedures.
   f. The encoding system shall be connected directly to the PLC.

2. Hardware requirements.
   a. Power fluctuations EMF and RF normally experienced in industrial and airport environments shall not adversely affect the manual encoding operation
   b. The manual encoding device shall be designed to operate in an airline baggage room environment. Separate conditioning of the power line, i.e., constant voltage transformers, shall not be required.

3. Manual Encoding System
   a. The manual encoding system shall be capable of a full range of graphic and text displays
   b. The mode of operation, numeric keystrokes of the operator or characters read by the

hand-held scan gun shall be displayed.

c. Information received in response to other user entries and entry combinations shall be displayed. This includes sort information and errors.

4. Hand held Scan Gun
   a. The handheld scan gun enables the operator identify a bag by scanning the machine-readable bag tag
   b. The tag information shall be displayed on the monitor stating that it was received from the scan gun.
   c. If the tag is readable, an audible alert should sound, and the green LED indicator on the hand-held scan gun should illuminate.
   d. The contractor shall also supply a holster type device to hold the handheld scan gun while not in use.
5. Connection
   a. Manual encoding device shall be connected by Ethernet directly to the BHS LAN
   b. Provision shall be included for transmission of tag data directly to the controlling PLC and the inclusion of a carrier ID to destination pier table.
6. Outdoor requirements
   a. The manual encoding station, handheld scan gun and the printer shall be suitable to be installed outdoor environment with specification suitable to handle Kenya. environmental conditions.
   b. Manual encoding station, handheld scan gun and the printer shall be installed under a well-ventilated outdoor cabinet (NEMA 4x) suitable to handle Kenya environmental conditions.

H. Electrical requirements

1. Cable Installation and requirements

   a. Cables shall be laid in galvanized cable trays, trunking and conduit. Cables used in the system shall comply with BS 6004. It shall be acceptable for final device terminations not to be contained however such final terminations shall not exceed 1.5m in length and in any event shall be suitably clipped to prevent undue interference with thecables.

   b. Cable trays used should be hot dip galvanized suitable to environmental condition in the project area as per related electrical specifications

   c. All Cable containment shall be sized to include for a 25% spare capacity to allow for future modifications.

   d. Cabling shall be adequately specified for its duty.

   e. The installation shall generally be of a good standard and tidy in appearance. The customer reserves the right to point out installation snags and the Contractor shall put such snags right at their cost.

   f. All field control wiring will be a minimum of 1.5mm2 single core or multi-core cables.

   g. All internal control wiring shall have low smoke halogen free outside jacket.

   h. All electric wire and cable shall be color coded and shall have wire numbers.

   i. Controls shall operate on 24 VDC. Control components shall not be subject to operation under loads exceeding manufacturer recommendation.

2. Emergency Stops

   a. The Contractor shall provide emergency stop devices for the additional equipment of the button, trip wire or press line type such that personnel will

not be more than 5 meters from an emergency stop device when working adjacent to the system.

b. The emergency stop circuits shall be zoned such that a line of sight rule is followed but with due consideration to allowing redundancy routes to remain operational in the event of an emergency stop where possible. Suitable overlap shall be provided between emergency stop zones. The Contractor shall advise in the tender response the EMS Zoning arrangement proposed.

c. In assessing the emergency stop requirements the Contractor is advised to pay particular attention to the EC machinery safety directives.

d. It shall not be acceptable to use any form of logic solving device such as a PLC in the primary Emergency stop circuits. Emergency stop circuits shall use an approved emergency stop safety relay, which provides contact monitoring. The emergency stop circuit shall be wired in a fail-safe manner using normally closed contacts on all devices.

e. All E-stop devices shall provide an additional Normally Open contact connected to its own PLC Input such that the operation of any E-stop device can be detected and displayed on the SCADA system and PLC HMI.

I. Telecom requirements

1. BHS Local area network:

a. The PLC cabinet switches shall be compatible with the existing switches and shall be connected to the existing network.

b. Cabling–Cabling shall be Ethernet 10/100/1000BaseT with unshielded twisted pair (UTP) cables, fiber optic or a combination thereof.

c. The UTP cables shall be plenum rated Cat 6 Cable defined by EIA/TIA- 568B and ISO/IEC11801 standard capable of 350 MHz All connections shall be made with RJ-45 connectors.

d. All connectors shall carry the same rating as the above cable.

e. The network cabling plant shall be arranged in a star configuration with a 10/100/1000BaseT Hub in the center.

f. All LAN cables shall be identified at both ends of the cable noting the controller or connection port. This shall also be reflected on all associated system drawings.

g. Redundancy–The LAN shall be designed in such a manner as to ensure full network capability in case of any single component failure.

2. Computer system requirements

a. Contractor shall provide all media and appropriate license keys, including but not limited to the following:

1) The original operating system

2) Databases

3) Anti-virus software

4) Any and all software that is part of the applications environment and was purchased and used in the development and / or execution of this project.

b. Contractor shall ensure that software and equipment versions shall be the latest revisions at the time of commissioning and shall be published and approved in design review meetings.

c. Contractor shall ensure that computer hardware provided to be appropriately sized for the application and identified by the Contractor in the proposal. Contractor shall ensure that the total average CPU load shall not exceed 40%.

d. Workstation components shall operate 24 hours per day, 7 days per week, and 365 days per year and maintain 99 percent availability during each operational day, excluding a four-hour window each day for maintenance and repairs.

e. Contractor shall ensure to provide System Status Monitor. Applications software running on the BHS Workstation that provides a graphical depiction of the BHS activities, alarms and other events.

f. Contractor shall ensure to provide all the passive and active components for the proper functioning of the system. Fully managed Ethernet switches shall be used.

J. Control Requirements

1. The control system interface with the check-in conveyors and shall provide a means for check-in discharge control which assures equal opportunity to all desks feeding a common collector conveyor.
2. Start-up of a subsystem shall be executed if all emergency switches controlling any zone are reset, local isolators in the subsystem are switch on and all fault conditions are reset.
3. Energy saving: The control system shall provide an automatically selected energy saving mode. This shall stop conveyors after a time period (adjustable via SCADA system and PLC HMI) since the last bag passed through each conveyor. The first conveyor in each route shall continue to run to facilitate loading of new bags. The passage of new bags through the system shall automatically restart conveyors, which have stopped in energy saving mode.
4. Dieback: The control system shall provide 'Dieback' control. If any conveyor is unavailable to accept bags arriving on the next upstream conveyor shall cause this conveyor to stop. Recovery from Dieback shall be automatic when the problem, which caused the Dieback, is cleared (i.e. when the downstream conveyor restarts, the conveyor previously stopped in die back will restart automatically). In this way the system shall handle any operational or fault conditions, which interrupt baggage, flow in an orderly and controlled fashion. Recovery from Dieback by upstream conveyor shall take place without loss of baggage tracking.
5. Each transport conveyor shall incorporate blockage detection to detect any bag jams or blockages, which may occur. Blockages or jams shall be represented on the SCADA and PLC HMI as a fault condition.
6. Operation of the emergency stops shall have an immediate action. Emergency stops shall be part of a fail-safe automation system integrated in the standard automation components. Status of the emergency stop shall be reported to the SCADA system and PLC HMI.
7. Each sub-circuit within the control panel shall be protected against short circuit, overload tripping devices shall be provided with manual reset to prevent automatic restarting.
8. Control system shall provide time-out errors on certain items where a blockage would occur
9. Control system shall be able to provide tracking and updating of the bags starting from the check-in delivery lines. Necessary sensors such pulse position indicators and photo eyes shall be used.
10. Remote support: a VPN connection shall be available for remote assistance to the PLC system. The PLC system shall be connected to a VPN server of the airport.

K. Operating modes

Control system shall be able to be operated in 3 modes

1. Nominal Mode
2. Crippled Mode
3. Maintenance Mode
4. Nominal Mode
   a. This is the system running in the normal operation. The sub-system can be started via SCADA or via the control panel. The in-line screening machines must be operational. When starting the system, first a sound a luminous indication will be present for a predefined time prior to the movement of the equipment. This mode requires the authorization of the SCADA supervisor.
   b. In case of SCADA failure, it shall be possible to start each subsystem from local control cabinets (by the mean of push button, operator terminal …): local mode.
5. Crippled Mode
   a. During this mode, defined backup scenarios can be selected. In this way, it is always possible to empty the system. Operational scenarios shall function during the sub system or system malfunction. The crippled mode shall be selected and operated by the Operation Supervisor (in agreement with Security, Customs and maintenance supervisors):
6. Maintenance Mode
   a. Maintenance supervisor (in coordination with operation supervisor) can select the maintenance mode, from SCADA or from local control

      cabinets. This mode is used in case of a breakdown or for maintenance procedures.
   b. This mode allows the maintenance operators to perform maintenance and adjustment operations.
   c. The maintenance mode does not allow automatic processes, but authorizes local individual commands.
   d. This mode allows work on a part of the system, which is then isolated of the rest of the system. The operator can then actuate each piece of equipment separately using a control box integrated in each equipment unit or which can be connected close by. When the maintenance mode is selected, automatically the subsystem shall stop.
   e. The following equipment is available for the maintenance team to perform their tasks:

      1) Control Panels

a) A switch to select the maintenance mode is available on the front panel of the control panel controlling a functional part of the system.

b) Selecting this mode shall stop the equipment within the chosen functional area.

c) Additional switches allow to locally and individually control each equipment. These commands shall only be applied to the selected equipment, without affecting the other equipment of the BHS.

2) Maintenance Laptop

a) one maintenance laptop shall be available for the maintenance team, to allow the operators to communicate with the PLC.

b) The industrial type laptop shall have the following functions:

- Analysis support (messages, alarm display…)
- Parameter setting
- Acknowledgement of some failures or problems on the system (jammed baggage, loss of follow-up, emergency stop acknowledgement, electrical failure acknowledgement…)
- Test (for example, status light).

3) Each individual device is equipped with a local maintenance box, allowing the selection of several operating modes:

a) Nominal mode

b) Maintenance mode with the possibility to control:

- Forward movement of the device
- Backward movement of the device

L. External Interfaces

1. Interface with Airport control system

a. Contractor shall coordinate the integration of the BHS control system with airport control network and as a minimum the following interface:
   1) BSM are to be received from DCS and BPM from the BHS sent to BRS or/and to DCS
   2) Flight schedule shall be received from FIDS.

b. BHS system is connected to airport network through BHS servers

c. BHS network Clock should be synchronized with the Airport network clock.

d. Programming within the BHS control system to be able to interface with the airport control systems (FIDS, DCS, etc.…) are within BHS contractor. BHS contractor and Main Works shall have to coordinate and agree on interface details, signoff and thereafter implement measures and configurations

required to enable the interfaces.

2. Interfaces with screening machines

   a. Contractor shall coordinate the integration of the screening devices in the baggage handling system.

   b. Safety interface shall be provided through safety signals as dry contacts

   c. I/O interface shall be used to physically control the transport of baggage.

   d. Data interface: this is the report on individual bags. A unique identifier and the security status is data to be exchanged. Preferable over Profibus.

3. Interface with Fire Alarm System

   a. Contractor is required to coordinate with end users and stakeholders Fire safety, Building control and Local Fire Authority for door control and program the fire and security doors.

   b. The Contractor shall coordinate to connect an input on each BHS PLC to a relay in a fire relay panel. Each PLC shall have a hardwired input for the fire signal.

   c. Fire door shall be integrated in the fire alarm system and in the SCADA system.

   d. The fire alarm system shall provide a signal to the BHS of the fire status relevant to each location of the fire doors. The fire alarm system shall not directly control any part of the system.

4. Interfaces

   a. All incidents and system failure alerts should be sent to employer's central Help Desk System.

5. General requirements

   a. It is in BHS contractor scope that system shall continue to be operational independently of the availability of interfaces and must have all functionalities available within the system to input the required information, i.e. flight schedules, Sort Allocation, etc. this doesn't apply to BSM.

M. Control room

Contractor shall provide furniture in terms of desks, equipment cabinets and chairs required by the equipment and the operators. Contractor shall ensure that coordination is taking place with electrical and telecom discipline to ensure that power and data outlets are properly located. Contractor shall ensure to allocate the required space for the SCADA workstation and the report printer. Control room setup shall be defined by Contractor and will be subject to Engineer / employer approval. Server rack related to the BHS will be included in the server's room.

PART 5 - EXECUTION

5.1 INSTALLATION

A. General

1. All installations to be made according to manufacturer recommendations and instructions. Special attention is to be given for protection against chocks by providing properly located knockers in the inbound area.

2. The Contractor is responsible for the all phases of installation during this project.

3. All workmanship and quality control shall adhere to and comply with industry construction standards.

B. Compliance with Drawing Package

1. All construction of the BHS upgrade shall follow the prescribed and agreed upon installation drawings.
2. Any divergence from these drawings will be considered out-of-specification and will be rejected unless changes are agreed upon prior to installation.
3. As-Built drawings shall accurately reflect these changes.

C. Work Duration

1. The Contractor is responsible for the timely completion of the project during the installation phase.
2. Any divergence from the schedule must be agreed upon by all parties and when necessary actions shall be undertaken by the Contractor to accelerate the installation process.

D. Employee Work Conditions

1. All tools and other construction equipment will be provided for by the Contractor.
2. All work spaces shall be kept clean and safe for employees and others who must access these areas.
3. The Contractor is responsible for the safety of all its employees while on the job site.
4. All applicable rules and regulations regarding employee behavior shall be followed.
    a. Employees shall not engage in drug or alcohol use within the facility
    b. Employees shall not, at any time, be under the influence of drugs or alcohol while at the job site.
    c. Employees shall not engage in any illegal activities while at the job site.
    d. Smoking is prohibited except in designated areas.

5.2 ACCESSIBILITY

The Contractor shall respect each of the following principles regarding the installation:

A. Platforms shall be installed in all locations where maintenance interventions are scheduled. They have to be designed to avoid any object falling down on to the lower levels (platforms and conveyors).

B. Protection and access mean of the equipment devices shall be designed to allow maintenance interventions without shutting down the surrounding devices working.

C. All maintainable organs shall be positioned on the side of the conveyors (motors, cells, belt tensioning organs…) and be accessible via the platforms.

D. The free width of maintenance way shall be at least 800 mm.

E. Portable means of intervention shall be avoided except when the technical impossibility to use stationary platforms has been systematically demonstrated.

F. The conveyors shall be spaced from walls or columns at least 300 mm provided that the other side be completely accessible, i.e.:

1. At least 800 mm free if the bottom of the conveyor is located at a height superior to 500 mmabove ground (or maintenance platform);
2. At least equivalent to the conveyor width in the other cases.

G. A 300 mm free space width shall be left in front of at least 1 front side (rectangular column) or ¼ circle (circular one) of each column, on the whole height, to allow installation of facilities (such as fire protection system…).

H. Specific means shall be put in place to receive the baggage that was accidentally ejected, in order to protect the personnel working at a lower level. Further, other means shall also be implemented to facilitate recovery of the fallen baggage.

I. Special handling means (tackles, hoists, winch and so on) shall be implemented in all locations where the maintainable unit's weight is superior to International Standards considering the intervention conditions (e.g. human intervention with one's arm straight out).

J. Shock-absorber protective materials shall fit all salient angles.

K. Access to platforms shall only be by steps (no ladder).

L. Footbridges used to cross the conveyors shall be installed so that all areas can be accessed without deviation or by-pass of more than 50 m. The footbridges must be equipped with steps, guardrails, and leave free height to enable progress of the maintenance staff in satisfactory conditions.

M. Accessibility to the devices (regarding stacked conveyors in particular) shall be possible, but under no circumstances the cable paths or outer conveyors can be used as a step.

N. Direct clearing of ground conveyors is allowed on condition that these points be marked out (no clearing possible out of mark out point) and secured by the automatic breakdown of conveyors (i.e. sensitive steps, safety line curtain, and so on). Emergency stops shall be positioned in every point of clearing.

O. Access for the operators has to be planned (and demonstrated) in order not to interfere, from the security point of view, the maintenance interventions.

P. In case of maintenance operation, any subsystem is easily disconnected of the others, which continue operating to work in goodconditions.

Q. In any case, making it impossible to observe one of these principles for particular layout restrictions, the Contractor shall make a request for deviation comprising the envisaged replacement means and/or the ergonomic studies that shall be submitted to the Employer for approval.

5.3 BELT CONNECTIONS

A. Two belts (crude, circled, or linear conveying) shall be interconnected in an overlapping manner and include chute of the upward belt on the downward belt.

B. Values of chute and overlap are function of the drum diameters used and of the nature of the adjacent conveyors (curve, flat, upward and downward conveyors, as well as injectors towards curved, flat, upward and downward conveyors).

C. Overlap shall also depend on the connection location (e.g. passage of a fire protecting

device).

D. Particular measures shall be taken concerning upward and downward belts adjacent to the X-Rays, according to the devices used.

E. This connection mode has not been considered for the special conveying modules (e.g. injection belt on to the sorting machine, if any).

5.4 Layout Requirements

1. General
   a. The Contract Drawings are intended to be a general guideline to the design of the overall BHS and do not necessarily show all the detailed segmentation of the conveyor lines. Any segmentation shown on the drawings shall, however, be followed as a minimum, except that additional queue conveyors and/or platforms may be required based on the guidelines below.
   b. Design the BHS to accommodate the following physical constraints imposed upon the BHS by either operational or facility considerations.
   c. If any design criteria cannot be maintained after the Contractor's investigation of all feasible solutions, submit an RFD for resolution.
   d. Adhere to the following guidelines for the detail design of the BHS:
2. Bag Clearance Requirements
   a. Provide a minimum bag clearance between the surface on which the bag is transported to the underside of any obstruction of 900 mm, unless otherwise noted on the Contract Drawings.
3. Minimum Staff Clearances
   a. Provide a minimum 2,100 mm of height clearance at all staff areas, all manned work areas, maintenance areas and BHS escape routes.
4. Minimum Vehicle & Staff Clearances
   a. At all make-up positions and cart/containers staging locations, maintain a minimum of 3,000 mm vertical clearance above the vehicle driving surface for the purpose of opening ULD containers with vertically hinged solid doors.
   b. The make-up cart/container staging zone shall be a minimum of 2,200 mm in width, adjacent to the make-up the operator plinths.
   c. At all other vehicle drive aisle locations, maintain a minimum of 3,000 mm vertical clearance above the driving surface.
5. Operator Plinth Sizing
   a. Unless otherwise coordinated operator plinths shall be 950 mm wide and 150 mm high.
6. Minimum Maintenance Access Requirements
   a. Provide catwalks and platforms to ensure compliance with all applicable codes, standards and the requirements of the TS. Ensure sufficient maintenance access points are provided to meet the performance criteria of the TS and to provide a safe, efficient, and easily maintainable BHS.
   b. Locate maintenance catwalks on a minimum of 1 side of all equipment unless accessible from building floor/walk surface. "Accessible" is defined as 1,800 mm or less from floor/walk surface to TOB except adjacent to high potential jam locations such as turns, merges, hinge conveyors, diverts and other similar high frequency jam locations where "accessible" is defined as 800 mm or less from floor/walk surface to TOB.
   c. All equipment shall have a primary maintenance access side from which all regular maintenance activities can be performed with the exception of a change of pulley or bearing. Locate any catwalk on this primary access side. Where maintenance activities are required on the side opposite of the primary access side, the equipment shall have a minimum clearance, when viewed from above, of 150 mm to any obstruction of 150 mm or less in width or 400 mm to any obstruction with a

width greater than 150 mm for the full conveyor and bag height clearance. Provide greater clearances where possible to facilitate maintenance activities.

d. Select motors/gearboxes that minimize protrusion into the catwalk and do not obstruct passage by maintenance personnel.

e. Catwalk shall have a nominal width of 1,000 mm and all catwalk locations shall be provided with a suitable means of access by stairs or ladders. Locate catwalk access stairs/ladders less than 40 meters apart based on catwalk travel lengths or within 20 meters walking distance to an access stair or ladder (when on the catwalk), whichever is less, unless building constraints make such a requirement impossible to achieve.

f. Provide a minimum of 1 access method for each catwalk segment; wherever possible, provide 2 access routes for catwalk more than 10 meters long. Provide a suitable number of catwalk conveyor crossovers to allow maintenance staff to cross over conveyor ROWs to access catwalk sections on opposite sides of conveyors without the need to travel down an access stairs/ladders and back up another access stairs/ladders.

g. Wherever possible, provide access stairs as the primary method to access catwalks. Where access stairs are not possible, provide ships ladders to access catwalks. Where ships ladders or access stairs are not possible, provide vertical ladders to access catwalks. Where vertical ladders are not possible, provide swing-down ladders to access catwalks. Do not locate swing down ladders in unsafe locations, such as vehicular drive aisles.

h. Design all BHS areas with a 2,100 mm minimum headroom clearance and 1,000 mm wide access clearance on platforms and walkways. In any BHS area where these requirements are not achievable revise the BHS design to comply with the TS requirements or as a final measure identify such locations within project submittals and seek resolution with the Owner. Coordinate with Others to ensure no services impede access to the BHS.

i. At any agreed locations where the clear height is less than 2,100 mm, install safety padding on the obstruction across the full length of the catwalk to protect maintenance personnel from injury. Padding shall be an appropriate and durable rubber or foam with a minimum thickness of 15 mm permanently attached without the use of adhesive tape. The padding shall be yellow with black stripes. Provide safety signage at each obstruction.

7. Minimum Routes for operational staff

   a. All access routes through the BHS to workplaces for operational staff (ground handlers, security, customs, and manual encoding staff) shall have a minimum width of 1,200 mm and a minimum clear height of 2,100 mm.

   b. Changes in elevation shall be based upon the provision of stairs; ladders cannot be accepted for operational staff.

8. Minimum HBS/CS Machine Installation/Maintenance routes

   a. Provide sufficient clearances for routes through the BHS to allow installation, removal, and maintenance of the HBS/CS Machines. If the HBS/CS Machine makes and models is not known during initial design, then provide sufficient space for routing for all HBS/CS Machines on the market and known machines under development with published dimensions. Where the HBS/CS Contractor has published requirements for such routes, then use these requirements. If there are no published route dimensions, then use reasonable sizes for movement of the largest shipping part of the HBS/CS Machine. Coordinate the list of HBS/CS Machines considered in the design with the Owner.

   b. If the HBS/CS Machine installation, removal, and maintenance route crosses other BHS equipment, such equipment shall be movable on lockable caster wheels and equipped with quick disconnect type electrical and controls connections (include clear individual makings to mitigate incorrect reassembly). Displacement and reinstatement into service of movable equipment necessary to remove or install the HBS/CS Machine shall not require more than 2 hours total.

9. ROW for Future BHS Expansions

a. Maintain clear ROWs for any future equipment as indicated in the Contract Drawings to allow the Owner to expand the BHS without the need to demolish any equipment installed under this Contract. Base clear ROWs for future equipment on the design developed for such future equipment.

10. Belt Conveyors

a. General

- Inclined and declined conveyors shall have a maximum slope of 18 degrees for non-tracking conveyors and 15 degrees maximum for tracking conveyors, unless otherwise indicated in the Contract Drawings. In all cases, where space permits a lower angle, minimize the slope utilizing the least possible incline/decline angle to achieve the proper elevation change.
- The maximum length of any conventional conveyor segment shall be no longer than 18 meters.
- Limit all power turns to no more than 90 degrees increments per conveyor.
- Avoid the use of spiral power turns wherever possible. Demonstrate that the use of spiral power turns cannot be avoided after investigating all feasible solutions.

b. Queue Conveyors

- Queue conveyors for standard gauge conveyors shall be 1,200 mm in length. A power turn of 45 degrees or more may be used as a queue conveyor, if designed with a suitable radius and equipped with a suitable drive and controls and the queuing capability with a maximum length bag is demonstrated.
- If the above requirements related the number of queue conveyors cannot be achieved due to building space limitations, then coordinate rearrangement at these locations and obtain design approval from the Owner.
- For Out of Gauge conveyors, the minimum queue conveyor length shall be 2,000 mm. Where this is not feasible an absolute minimum requirement of 1,500 mm shall apply.

c. Diverters

- Provide horizontal and vertical diverters with minimum capacities as defined in Table 26. The capacity is defined based on the diverter having to switch destinations for each bag. When the diverter does not have to switch position for each bag, the throughput shall be equal to the throughput of the conveyor line on which the diverter is located.

Table 6: Diverter Minimum Performance Requirements

ID	Diverter Type	Minimum Performance Requirement
1	VSU & VMU	25 bpm, when switching for each bag (one-for-one)
2	Pivoting Conveyor	5 activations per minute (not switching for each bag)
3	HSD	45 bpm, when switching for each bag (one-for-one)
4	LTD	5 activations per minute (not switching for each bag)

No more than 0.5% of bags in operational baggage tubs may be separated from their tubs after a discharge or divert except at the final sort output locations (discharge from conveyor onto make-up

device) where no more than 5% may be separated. Demonstrate this with typical bags transported in tubs during normal operations.

- VSUs and VMUs are to be constructed with the following capabilities:

Table 7: Design Load Capacities of VSUs & VMUs

#	Description	Requirement
1	Static Load Capacity	150 kg/m
2	Dynamic Load Capacity	50 kg/m
3	Belt Speed	As required for specified processing rates

11. Tilt Tray Sorter
    a. The TTS track shall be completely level without any incline or declines.
    b. The TTS layout shall conform to the manufacturers' recommended design parameters.
12. Tub Return
    a. All inclines and declines shall not exceed 18 degrees.
    b. The maximum length of a tub return conveyor shall be no longer than 18 meters.
    c. The height of the load conveyor shall be 400 mm from top of the curb.
    d. The maximum number of tubs in a tub stack shall be 4.
    e. Provide the quantity of queue positions as shown in the Contract Documents, at minimum. Provide additional queue positions if needed to achieve the performance requirements.
13. System Resilience
    a. The BHS shall provide sufficient resilience so that in the event of a failure on any single processing capacity, the remaining capacities are sufficient to process 75% of the peak design demand, as demonstrated through the simulation fault scenario testing.
    b. The HBSS shall be designed around an N+1 principle, where the BHS/HBSS shall have sufficient capacity to meet the peak design demand in the event of the loss of a single HBS machine.
    c. The power and controls design shall consider resilience requirements. Similar processing capacities shall be sub-divided between power supplies and control zones to ensure that the loss of a single power supply shall not disable an unacceptable % of the BHS for that processing capacity.
    d. Single points of failure shall be avoided where possible. Each shall be highlighted in submittals.
    e. Identify any instances where the BHS does not meet the resilience requirements. Demonstrate why the resilience requirements cannot be met and propose a concept of operations for the processing of bags in the event of a BHS outage. In the event the Owner does not approve the deficiency, modify the BHS design to provide additional capacity in order to meet the resilience requirements.

5.5 BHS Functional Design Specifications

a. Submit FDS's describing all Power, HLC & LLC functionalities, HMI screen interfaces and fallback procedures for failure modes of operation.
b. Prepare the FDS following the structure below:
    - FDS – System Description
        - System Description
        - Concept of Operations Description
    - FDS – Power Distribution
        - Interface to the building power supply
        - Power requirements calculation method
        - Calculated power requirements

- Redundancy of power distribution
- Grounding/Earthing method
- Power factor correct and power conditioning provisions
- Calculation of UPS requirements and details of UPS provisions

- FDS – LLC
  - Control System development and implementation master schedule
  - Schedule of System hardware employed
  - Interface with inline and check-in weighing equipment
  - Interface with HBSS/CSS equipment
  - Full and detailed description of the proposed BHS tracking algorithm
  - Full and detailed description of HBSS associated routing
  - Start-up/shutdown procedures
  - Description of BHS control logic outlined by subsystem
  - Automatic operational/maintenance/defect/status routines
  - Audio/Visual indications
  - Control station layouts/functions/operations
  - Fall-back/Anti-grid lock procedures
  - Redundancy schematics/provisions
  - Submit an overall System architecture diagram clearly identifying LLCs. At minimum, show all PLCs, power distribution up to one level above motors, network switches connected to PLCs, ATR's, CBS machines, existing PLCs that interface with the Works and any other major element of the LLCs.
- FDS – HLC
  - Interfaces to external systems
  - Interfaces to existing systems
  - SAC system
  - Empty carrier management
  - SCADA system
  - HMI/GUI
  - MIS Reporting Functionality with sample report formats
  - User Right Management
  - BVMS
  - Network and IT hardware
  - Resource planning and bag destination lookup (i.e., SAC functionality)
  - Overall System architecture diagram clearly identifying HLC with respective networks

2. BHS Layout Drawings
   a. Submit a comprehensive set of plan views, elevation/section views layout drawings defining the entirety of the BHS project scope.
   b. Demonstrate dimensions of all new, modified, and relocated equipment including conveyors, ULD stillage, racking, Steelwork and control panels.
   c. Demonstrate vertical and horizontal operational and maintenance access and vehicle clearance dimensions.

d. Demonstrate the escape routes from the BHS spaces identifying the distance of escape routes to the nearest exit. Highlight the worst-case conditions in each area of the BHS.
e. Demonstrate all Subsystem, equipment references and equipment lengths.
f. Demonstrate HBS/CSS machine replacement route clearance dimensions.

3. Conveyor List
   a. Submit a conveyor list that shall as a minimum include the following information:
      - Conveyor
        - ID
        - Type
        - Function
        - Conveyor Length
        - Conveyor Width
        - Conveyor Angle of inclination
        - Throughput Capacity
        - Belt Speed
        - Belt Type
        - Total Belt Length (endless length or length including vulcanising allowance)
        - Single or Bidirectional
        - Drive handing
        - Notes
      - Gearbox Type
      - Motor Characteristics:
        - Motor kilowatt,
        - Voltage,
        - Phase,
        - Source,
        - VFD (if applicable),
        - Circuit breaker size,
        - Efficiency (e.g., IE4),
        - Function variant description (e.g., straight, curve, etc.)
        - Overload protection.
      - Notes

4. System Power & Heat Output
   a. Submit the System power (heat output) requirements which shall include calculations for the areas of the facility listed below. The information shall include friction losses from BHS equipment and heat output from the drive motors, MCPs, and computer equipment.
   b. At minimum, provide System power information for the following areas:
      - BHS Control room
      - BHS MCP room
      - Conveyor equipment enclosures
      - Equipment grouped by different building areas based on HVAC zones
   c. Submit all the control panel sizes and related power requirements for all Subsystems of this project. Submit all the revised power requirements for the existing modified systems. The power requirements shall indicate conveyor control group and conveyor segment kilowatt removed, kilowatt added, and the total connected load of the new and existing modified Subsystems (kW, KVA, and full load amps). The electrical loading requirement of the System shall not exceed that shown in the TS.
   d. Illustrate (in colour) in plans how the BHS shall be powered to satisfy redundancy requirements.
   e. Submit the basis for calculating demand load relative to connected load including diversity factors, chosen drive size versus calculated demand, and maximum load on a conveyor versus maximum load across all conveyors simultaneously.

5. System Equipment Calculations

a. Provide a package of calculations to demonstrate how each of the BHS products and components meet all applicable performance requirements of the TS. The package shall include minimum, typical and worst-case conditions for each product type, considering:
    - Components – Pulleys, Rollers, Bearings, Belt Pull
    - Drives
    - Control Panels

6. Steelwork Typical Design
    a. Provide drawings and specification sheets to demonstrate in detail the design principles to be employed for each type of BHS Steelwork deployed on the Project.
7. System Availability Calculations
    a. Provide a detailed system availability report showing Availability, MTBF, and MTTR (as applicable for) for:
        - Individual BHS equipment (mechanical, electrical, network & IT)
        - Individual BHS Subsystems
        - Overall BHS
8. Detailed Design Specification
    a. The DDS shall comply with international software practices and shall be written such that it can be passed on to a software engineer to begin writing code and therefore it shall detail function blocks, links between function blocks and other requirements to allow coding of the software directly from the DDS.
    b. If certain parts are required to be operational prior to others, submit FDSs and DDSs for these sections of the BHS earlier than other sections.
9. BHS Control Room Equipment
    a. Submit BHS Control Room equipment requirements containing all information pertaining to the proposed computer/control hardware including:
        - A proposed room layout of equipment showing spatial requirements
        - Environmental requirements (temperature and humidity)
        - Raised floor for cable access
        - Cable routing in the Control Room
        - UPS sizes and locations
        - Fire protection and suppression
        - Electrical power requirements and distribution
        - Location of utility power outlets for workstations, printers, BVMS control station, walkie-talkie chargers, video wall and other ancillary equipment
        - Suggest lighting concept based on layout of Control Room
10. BHS Operator Interface Drawings
    a. Submit drawings demonstrating BHS-Operator/PAX interfaces. As a minimum, drawings shall include:
        - PAX to:
            - Check-In Conveyor (Standard & OOG)
            - Arrivals Carousel (Standard & OOG)
        - Operator to:
            - Control stations in public areas
            - Control Stations in non-public areas
            - MES Equipment
            - ILS
            - BCR
            - TMS
            - HBS Level 2
            - HBS Level, 3, 4 and Level 5 TCU
            - Arrivals/Transfer Input conveyor (standard & OOG)

- OOG BHS lift
- Make-up devices
- TTS maintenance station

- Provide the detailed design of:
  - Operator Interface Covers
  - Recessed Supports with Kickstrips

5.6 Spare Parts

1. General
   a. Submit the recommended spare parts and consumables inventory levels, as identified in the TS. If approved by the Owner, ensure the spare parts and consumables inventory is onsite before Preliminary Acceptance.
   b. All parts shall be designed with a lifetime of 15-years. However, this shall not relieve the Contractor of the responsibility of supplying the minimum required quantity of spare parts.
   c. The price per unit for the spare parts shall have the same monetary value as the unit price listed in the BHS Contract. The spare parts unit price shall be valid and remain unchanged through to Final Acceptance.
   d. The Owner shall be permitted to inspect the onsite spare part store at any time.
2. Spare Parts List
   a. Submit a comprehensive spare parts inventory list identifying all spare parts and quantities to be held on site by the Contractor.
   b. Organize the list by discipline and include the part description, quantity installed, recommended spare parts inventory level, lead time, supplier name and OEM part number, and price including delivery.
   c. Provide a minimum quantity of 2.5% spare parts of the totally installed quantity of each particular part, or a minimum of 1 unit for short lead time items and minimum 2 units for long lead time items, whichever is the greatest.
   d. Where parts can be replaced with alternative parts from different suppliers that have equal characteristics, such as bearings or photocells, with the same form factor, performance and connections and do not require any modification to the BHS or product, provide an alternative part supplier with a part number.
   e. The list shall include parts critical to the operation of the System but not normally used in preventative and typical corrective maintenance and may require replacement as a secondary consequence of a failure.
   f. Indicate the general storage environmental requirements for spare parts. If certain parts have special storage requirements, then identify such parts and their recommended storage conditions.
   g. Identify the estimate of spare parts consumption, including consumables, for a 10-year period.
   h. Identify any item that's of a hazardous material.
   i. Spare parts shall be identified in a spare parts list that shall include all spares required for all products supplied on the Project and shall include a consolidated set of spare parts required from the Contractor's sub-suppliers within the single consistently formatted spare parts list. The list shall, as minimum include the following:
      - Mechanical Spare Parts
        - Weighing scales
        - Conveyor frames
        - Power turn components
        - Spiral turn components
        - Horizontal Merge components
        - Horizontal Divert components
        - VSU components
        - VMU components
        - Bag Dimensioning Devices

- Lift components
- Belting
- Drive assemblies
- Motors
- Pulleys
- Rollers
- Chains
- Shafts
- Bearings
- Lubrication
- TTS trays
- TTS carriers
- TTS side guards
- TTS linear motors
- Section of TTS straight track
- Section of TTS curve track (turn)
- Vertical carousel shelf
- Vertical carousel shelf bearings
- Vertical carousel drive mechanism
- Slide bushings for Non-Powered Gravity Roller Conveyors

- Electrical Spare Parts
  - Cables
  - Connectors
  - Boxes
  - Control stations
  - Pushbuttons
  - Lanyards
  - Fuses
  - Breakers
  - Contactors
  - Capacitors
  - Varistors
  - Actuators
  - Thermostats
  - Displays
  - Beacons
  - Horns
  - Fans
  - Panel lighting
  - Press lines
  - Safety edges
- Control Spare Parts
  - Sensors
  - Switches
  - Relays
  - Light curtains
  - Laser scanner heads
  - Laser scanner blowers
  - Laser scanner controllers, network cards, connectors
  - RFID equipment (tags, readers, writers, antennas)
  - PLC CPU, RAM
  - LLC bus equipment
  - Motor starters
  - Touchscreen control panel for vertical carousel
- IT Spare Parts

- CPU
- Graphics cards
- Network cards
- Motherboards
- RAM
- Hard drives
- Power supplies

- BVMS Spare Parts
  - Camera
  - Lenses
  -
  - Video cards
  - Matrix box
  - Switches
  - Operator control station
- Paging/Intercom Spare Parts
  - Handsets
  - Speakers
  - Switch board parts
- BHS LAN and WLAN Spare Parts
  - Routers
  - Switches
  - Repeaters
  - Cables
  - Fans
  - Power Supply
  - Antennas
  - Wireless Handheld Scanner
- MES Spare Parts
  - MEC including touchscreen monitor
  - Wired handheld scanners
  - Label printers
- Consumables
  - Barcode labels
  - Lubricants
  - Fasteners, nuts, bolts, washers
  - Welding electrodes
- Made to Order Spare Parts
  - List equipment and parts that are not practical to stock as part of the spare parts inventory and provide the Owner with their appropriate lead-time and unit price delivered.

5.7 FACTORY ACCEPTANCE TEST (FAT)

A. The purpose of the factory acceptance test is to demonstrate and document the readiness to install the system at the project site. This test will validate that the system is complete, functional and that the operator interface and system reports are consistent and compliant with this specification.

B. The system shall not be installed at the project site prior to successful completion of this test.

C. The FAT shall include, but not limited to the following:

1. All graphic and text status and alarm notifications

2. All sort functionality as described in this specification

3. All operator interface functions

4. All maintenance and operations reporting functions, including the successful population of all required data fields from data collected in the execution of these tests

5. Connectivity to third party system (airport system, scanners, fire alarm panel, etc)

D. This test environment shall connect to the functional PLC's as used in the project for the purpose of providing data representative of the site environment

E. The use of simulator to provide data from scanning arrays, and other third-party system.

PART 6 - TRAINING

A. Engage a factory-authorized service representative to train Employer's operations and maintenance personnel to adjust, operate, and maintain BHS equipment. Refer to Division 1 Section "Demonstration and Training"

1. Schedule at least one (1) week of site training.

2. Provide in-class and in-field training.

3. Contractor to submit training program for review and approval by the Client and the Engineer.

4. Contractor to carry out video recording of training

5. Certificates will be issued to each case delegate. Course feedback forms will be supplied to each delegate for their completion.

PART 7 - TESTING AND COMMISSIONING AT SITE

The BHS equipment needed for the upgrade shall be installed and fully tested (mechanical and controls equipment, and software) on site by the Contractor with recommended instructions and on-site guidance in the presence of the Employer and the Engineer. Contractor is to provide the test bags needed for testing the system. The quantity of those bags shall be equivalent to at least 40% of the system's capacity.

Any deficiencies or exemptions to the Specification shall be handed on to the Contractor who shall, within an acceptable time frame, perform the corrective measures.

Equipment will be subject to site performance testing for a period of at least seven (7) days.

Site performance testing shall establish that the equipment supplied meets the requirements set out in this specification and also that the Contractor has demonstrated the equipment is capable of the performance specified in this specification.

Z300 - PASSENGER LOADING BRIDGES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including Conditions, Project Requirements and other Division 01 Specification Sections, apply to this Section.

B. Contractor shall refer the specification volume (MTB specifications sections) where items are described to match the similar FLB and MTB products. Contractor shall consider the applicable sections as part of the tender documents, and shall meet all the technical requirements, accordingly.

1.2 SUMMARY

A This Section covers Passenger Loading Bridges (PLB) as shown and as specified.

B Engineer, design, fabricate, supply, and install working Passenger loading bridges of the apron drive type with completely enclosed walkway assemblies, capable of extending from the fixed loading bridge structures to the designated aircraft parked at the concourses.

1.3 WORK INCLUDED

A Unless otherwise specified or shown, provide all plant, labour, materials, tools, equipment, apparatus, facilities, design services and perform all operations and incidentals necessary to fabricate, deliver, install, test, and certify for operation the PLB as shown. The work for each PLB includes, but is not limited to, the following:

1. Rotunda assembly complete with weathertight interfacing connections between the bridge tunnel and the fixed loading bridges.
2. Telescoping tunnel sections with glazing walls.
3. Cab with PLB control console, weathertight door and aircraft closure piece.
4. Service stairs, landings, and access door where feasible.
5. Drive assemblies including lifting and braking mechanisms.
6. Rotunda supports, including supply of foundation anchor bolts and grouting at base plates.
7. Electrical equipment and devices for power, grounding, lighting, PLB controls and monitoring including all necessary conduits, wires, cables, junction boxes and hardware.
8. Console telephone, wiring and data port for voice and data transport to Terminal.
9. Incoming main supply power interfacing cabinet.
10. Underside-mounted collapsible PLB, PCA and GPU power feeder cable systems.
11. Automatic bridge levelling system.
12. PLB movement proximity sensors.
13. PLC bridge controls with provisions for fully automatic docking system operations and interfacing with the Aircraft Visual Docking Guidance System (VDGS) provided by others.
14. Passenger Loading Bridge Control Monitoring System (PLB CMS) and

integration with aprons systems (PLB, PCA, GPU, GOS and GSE water pumping station).

15. Air conditioning units type roof tops, one at the external tunnel and one in the inner tunnel.
16. Exterior and interior finishes, lighting, insulation, and sealing as required.
17. Special tools and recommended spare parts.
18. Operations and maintenance manuals.
19. Operators training.
20. Furnish & Install a new fire extinguisher, UL Listed, ABC Rated 3A:40B:C
21. Fire Alarm installation and connections.

B PLB Schedule:

1. Refer to fleet mix.
2. Refer to the PLB Schedule, the manufacturer of Passenger Loading Bridge should provide the drawings and schedule of the final PLB because it depends on their product for unit quantity and the operational requirements for the bridges to be furnished.

C Related Gate Equipment:

1. Gate equipment to be bridge-mounted include the following:
   a. Aircraft Pre-Conditioned Air units (PCA)
   b. 400 Hz Aircraft Ground Power Units (GPU)
2. The PLB, PCA and GPU shall be supplied by the PLB Specialist Contractor (e.g., the PLB manufacturer).
3. Contractor has the overall responsibility to coordinate and interface with the PCA supplier, and the GPU supplier to ensure that these elements are properly mounted to the PLB and that they are provided with the necessary utilities to render them fully functional as intended by each of the individual manufacturers/ suppliers.
4. Similarly, when furnished by separate suppliers, Contractor has overall responsibility to coordinate and interface with the PCA and GPU suppliers and require these suppliers to coordinate together and to provide detailed requirements to the PLB manufacturer such that the interfaces among the various suppliers are clearly defined and the various components function as a complete and single integrated system, as intended.

D PLB CMS - SCOPE OF WORK

1. Revise the following paragraph(s) to suit Project. Refer to Division 27 Section “Common Clauses for IT, Security & Special Airport Systems”.
2. Other Clarifications Related to the Scope of Work:
   a. The PLB CMS shall utilize the Project Structured Cabling Network and Data Communications Network Installations. This connectivity shall form part of the Structured Cabling Network and Data Communications Network as applicable. It shall not form part of the PLB CMS system.
   b. Network switches and other similar devices which are strictly dedicated and configured for the PLB CMS system, but installed remotely from the PLB

CMS headend, shall form part of the work for the PLB CMS system.

c. Inter-wiring, conduits and related accessories, network connectivity and any other material which is specific to the PLB CMS central equipment, and which is required to provide a complete operational system, shall form part of the PLB CMS system.

d. All interfaces to the airport systems shall occur through the Master System Integration (MSI). See Annex A of Division 25 Section "Master System Integration (MSI)" of the Specifications.

3. PRODUCTS AND WORK BY OTHERS

a. The Employer may separately purchase and/or provide certain equipment and miscellaneous items that will be installed during the course of the installation process. Such items may not be indicated in the Specifications. Contractor shall coordinate with the Employer and his Suppliers when considering:

i. Structured communications system cabling, termination, identification and testing.

ii. Provision and installation of phone systems, computer hardware, racks/cabinets and related networking software and equipment.

iii. Active communication and data processing equipment.

iv. Fiber optic cabling infrastructure.

v. Provision and installation of a Virtualized Servers Environment.

vi. Provision and installation of UPS in communications rooms.

vii. Communications grounding busbars and grounding wires connecting to the main building earth electrode system.

viii. Dedicated power panels, ground busbars, circuits, floor boxes and utility outlets.

ix. Installation and finishing of plywood backboards.

x. Building mechanical ductwork, cooling/heating system and environmental control sensors.

xi. Communications pathway devices such as cable trays, conduits, conduit sleeves, and penetrations in walls and floors.

b. Accordingly, Contractor shall:

i. Meet jointly with representatives of above systems, Contractors, Operators, Engineer and Employer to exchange information and agree on details of project implementation, equipment arrangements and interface, etc.

ii. Record agreements reached in meetings and distribute record to participants.

iii. Adjust arrangements and locations of equipment in technical rooms to accommodate and optimize arrangement and ensure necessary interface with other systems.

iv. Coordinate with the other Contractors whose deliveries are necessary for the correct operation of the PLB CMS including but not limited to the Data Network, Master Clock, MIS, MSI, etc.

v. Coordinate chases, slots, inserts, sleeves, and openings with general

construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.

vi. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.

vii. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the Work. Coordinate installing large equipment requiring positioning before closing in the building.

viii. Coordinate electrical service connections to components furnished by utility companies.

ix. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electricity-metering components.

x. Comply with requirements of Authorities Having Jurisdiction and of Utility Company providing electrical power and other services.

xi. Coordinate with the IT Contractors.

xii. Coordinate with the main Contractor for the final locations of the display units based on the adopted mounting type (pole mounted, bracket mounted or mounted on building façade).

xiii. Clearances required by International Regulations shall be respected. In case of a conflict, the issue shall be raised to the Engineer accompanied with the proposed solution for approval before proceeding with any works. It is the Contractor's responsibility to ensure that the required Regulations and Clearances are met.

1.4 WORK NOT INCLUDED

A The following work is not included in PLB package:

1. Fixed loading bridges (FLB).
2. Foundation work below the finished elevation of the apron.
3. Electrical system upstream of the main power supply interfacing cabinet.
4. Visual Docking Guidance System (VDGS) and VDGS operator panel.

1.5 DEFINITIONS

A Left and Right: When referring to “left” or “right”, the observer is positioned with his/her back to the terminal end and facing the aircraft end of the PLB.

1.6 SYSTEM DESCRIPTION

A This specification describes a system developed during detailed engineering that is considered to be suitable and appropriate. It is not intended to be prescriptive. Contractor may propose alternative arrangements provided that the system design criteria and system functional requirements are met.

B General: The PLB assemblies and the Fixed loading bridges (FLB) are designed to enable passengers to enplane and deplane completely protected from the elements during normal or

emergency operations while the aircraft is parked at the designated gate position. All the designated and alternate aircraft listed on the Schedules are accommodated.

C Scope: All necessary apparatus, equipment, and field labour and supervision to install and checkout factory assemblies and system components is included in the scope, including foundation baseplates and the bridges' flexible interfacing connections with the fixed loading bridges.

D Rotunda Assembly: The rotunda assembly is located at the terminal end of the PLB. It consists of a corridor, rotunda, and a support column. The rotunda assembly is designed so that no loads or vibrations are transmitted to the fixed loading bridges. The rotunda assembly is designed as the terminal end pivot for both PLB vertical and horizontal motions.

1. Corridor: A fixed interfacing walkway structure is provided between the rotunda and the fixed loading bridge. The corridor is designed to allow the installation of flexible weather seals and a floor threshold to the face of the fixed loading bridge.
2. Rotunda: A smooth transition between the fixed loading bridge interface and telescoping tunnels is provided. Flap type seals are provided for weather protection between the rotunda and the adjacent hinged tunnel section.
3. Support Column: A structural column, including anchor bolts, is provided to support the PLB assembly. The column is designed to rest on an apron foundation supplied by Employer. The apron foundation will be designed to meet Contractor's requirements.
4. Electrical Panel: The PLB's electrical disconnect panel is mounted on the PLB column support.

E Telescoping Tunnels: Telescoping tunnel sections are provided to connect the rotunda assembly with the cab section, with the largest cross section tunnel section physically closest to the aircraft. A hinged transition ramp is provided to accommodate the difference in elevation where telescoping tunnel sections overlap. The tunnels are moveable horizontally and the cab (aircraft) end is able to be raised and lowered as necessary to match the doorsill height of the designated aircraft. Tunnels are equipped with an underside-mounted electrical cable conveyance system through a movable drag chain in the direction of the tunnels' horizontal movements. The cable system is accessible for inspection at all PLB positions.

F Cab: A cab assembly is located on the aircraft end of the PLB. The cab is designed to rotate from the PLB / tunnel centreline so that the PLB can be fitted to the parked aircraft. The aircraft end of the cab is equipped with a folding bellows-aircraft closure. The closure is designed such that, when fitted against the fuselage, it surrounds both the open aircraft door and the doorway to protect passengers from the elements. The cab floor is adjustable to provide a smooth platform at the same height as the aircraft doorsill. No raised surfaces that may introduce a tripping hazard to the passengers are allowed, regardless of the position of the cab floor or the PLB. The cab is equipped with a forward-facing control console. An all-weather roll-up door is provided adjacent to the console to seal and secure the interior when the PLB is not in use.

G Control Station: A PLB control station is located at the aircraft cab end, where it provides the operator with a control console, service utilities, and control interlocks required to accomplish PLB operation. The control station compartment is positioned on the left side of the cab. The position of the operator is oriented to face forward in full view of the aircraft during the manoeuvring and docking operations. The PLB is designed such that operation of the PLB can be accomplished from the control console without opening the weather door.

1. Automatic control of PLB lights, roof top units and all other dependent services shall be done by the PLB PLC based on the Flight Schedule from the GOS/MIS. Unit shall switch ON/OFF at a pre-programmable time interval before and after the flight schedule.
2. PLB movement shall be interlocked with PCA unit system and GPU unit system.
3. PLB movement shall be interlocked with PCA unit cabin temp sensor in its "holder" position.
4. PLB movement shall be interlocked with GPU cable management systems.
5. Alarm from the smoke detector of the PLB shall be interfaced to the Building Fire Alarm System
6. Provide interlocks between VDGS and PLB in coordination with the VDGS contractor requirements:
    a. Bridge in – Signal from PLB to BDGS when the PLBs are not in parking position or in the safety area.
    b. PLB Lock – Signal from VDGS to PLBs when the VDGS is in docking mode, this signal locks all the PLBs movements.
7. Supply and install a pushbutton "VDGS emergency stop" on the PLB control desk.

H Control Console: A control console is provided in the operator compartment. All necessary indications and controls for all movements, interior and exterior lighting status and controls, controls and status indications for the auto-height feature for the bridge are included. The control console is protected from the outside environment.

I Service Access: The Service Access is comprised of a service door, landing and stairs leading to the apron area. One service access is provided at the cab end of each PLB, where layout constraints allow it.

J Each PLB is provided with suitable connections and outlets, prefabricated and pre-wired to accommodate the installation of telephone, data transmission, security devices, and/or intercom equipment and convenience electrical outlets at the control console. Internal lighting and under-bridge external lighting are provided. On/off lighting controls are provided.

K Power Supply: The power supply furnished by two (2) line feeds with 400 V, 3-phase + Neutral and PE, 50 Hz. Power requirements of the PLB line feeds are as follows:

PLB main supply: max. 100 A

PLB Air Conditioning supply (Roof Tops): 200 A

L UPS: connect to 230V AC UPS power supply from Rotunda UPS (electrical outlet provided by facility contractor) to supply PLB critical components such as control system, including PLC, touch screen, safety shoe, auto leveller etc.

M ECBS: connect to 230V AC ECBS power supply from Rotunda ECBS UPS (electrical outlet provided by facility contractor) to supply emergency lighting and exit signs.

N PLB CMS: it is designed to monitor on real time the status of Stands and all interfaced items (PLB, PCA, GPU, GOS and GSE water pumping station). The "PLB CMS" centralizes data available from the interfaced items and from the Airport Operation Systems in order to inform Maintenance and Operation of the availability and the status of the equipment monitored by the "PLB CMS". The main

functions, but not limited to, of the "PLB CMS" shall include:

1. Display overall view HMI.

2. Display specific Docking aircraft live in correct position and in scale,

3. Monitor and Display PLBs alarms and event messages, not limited to power supplies status, Air conditioning status, Limit sensors, Anti-collisions, Auto-levelling alarms, Emergency stops, VDGS interlocks, PLC failure, PLC configuration and diagnostic and Communication failures,

4. Display status, operating mode and positions of the PLBs, not limited to Off/On /Auto- levelling/automatic pre-positioning, Preposition, Parking, docked, Bridge-In, PLB Locked (VDGS), Faults, Operator logged-in, Duplicate information displayed on the Touchscreen…,

5. Monitor communication between "PLB CMS" and PLCs,

6. Send messages to PLB operator on the PLB touch screen from the O&M workstation.

7. Send flight schedule for the stand and expected aircraft type to each PLB. The "PLB CMS" provides the PLBs with the aircrafts type expected on the stand, as well as the estimated arrival and departure time, the flight number, stand number

8. Manage Users login and password.

9. Inform about maintenance schedule (corrective and preventive maintenance), not limited to Display PLB maintenance schedule, including expected time of unavailability and Lock a PLB for maintenance purposes (mostly in case of failure of one component of the PLB) from the O&M workstation.

10. Create and Edit O&M reports based on selected criteria,

11. Store all PLBs data, events, consumptions, maintenance downtime, metering and data information available in the PLB, stand occupation,

12. Analyse and filter PLBs data based on selected criteria,

13. Back-up PLBs data,

14. Synchronize PLB (PLC and Touchscreen) time with the Airport Master Clock using NTP,

15. The PLB CMS centralizes the data available for PLBs

1.7 DESIGN AND PERFORMANCE REQUIREMENTS

A Structural Criteria:

1. Wind Load, W: Calculate wind load on each PLB structure in accordance with BS EN 1991- 1-4, for the following parameters:
   a. Basic wind speed (10 min): 30 m/s
   b. Importance factor: 1.15
   c. Terrain Category: 1

2. Temperature Load: Unless otherwise specified, design the PLB structures for a uniform temperature increase or decrease of 17 deg C.

3. Seismic (Earthquake) Load, EQ: Design all PLB structures and components in accordance with RS 112 AND BS EN 1998 (TYPE 1) for the following parameters:
   a. Design Ground Acceleration: ag=0.25g

b. Importance Factor, IE: 1.2

A. Soil Class: Refer to Geotechnical report

4. Dead Loads, D: Include in the Dead Load the weight of the structure and all permanently attached equipment and accessories, including weights of bridge-mounted gate equipment, as selected.

5. Live Loads, L: Include in the Live Loads due to intended use and occupancy of an area, moveable equipment and partitions (e.g., loads associated with movement of the PLB), and vehicle loads (e.g., motorized wheel chairs, small baggage tugs), but in no case design for less than 320 kg/m2.

6. Roof Load: Design for a roof load of 75 kg/m2 and 100Kg of punctual load.

7. Design all mechanisms for actuating, guiding, and restraining the PLB and its associated components so that no noise or sway is apparent to the passengers using the PLB. Do not allow operating vibrations or loads to be transmitted to the fixed loading bridges from the PLB.

8. Provide sufficient torsional rigidity in the structural design to avoid excessive sway when the PLB is brought to a gradual stop.

B Mechanical Criteria:

1. Design temperatures: Base the design on the following ambient outdoor design environment (design temperatures):

a.	Summer:	Dry Bulb Temp:	32.8°C (26°C for 100% fresh air unit)
b.		Wet Bulb Temp:	21.17°C (23.08°C for 100% fresh air unit)
c.		Maximum Temp:	40°C (for air-cooled equipment)
d.	Winter:	Dry Bulb Temp:	13.2°C
e.	Mean Exposed Sunlight:	Maximum Temp:	75°C

2. Weather Data: Design the PLB and all associated components to withstand the following extreme climatic conditions and operation without damage or failure:

a.	Relative Humidity:	100% is common throughout the year, and may occur at temperatures in excess of 30°C
b.	Solar Radiation	Peak 1,000/W/sq.m
c.	Precipitation:	180 mm/hr.

3. Additional Environmental Design Considerations: Design the PLB and all associated components and appurtenances to comply with the following general requirements:
   a. Design the PLB to operate satisfactorily under the ambient temperature and humidity conditions identified above and loads.
   b. Design and select all components and materials for long operating life service under such conditions, especially the airport's coastal humid and saline environments.
   c. Make all electrical junction boxes used on the PLB from high strength non-corrosive materials NEMA 4 rated or greater. Painted steel boxes are not acceptable.

1.8 CONFIDENTIALITY

A. Refer to Division 27 Section "Common Clauses for IT, Security & Special Airport Systems".

1.9 QUALITY ASSURANCE

A General:

1. Manufacturer will employ and require its suppliers to employ, a Quality Management System that controls the design development, manufacturing, installation, testing and inspection of the equipment. Unless accepted otherwise by the Project Manager, use manufacturers and installers that employ a Quality Management System complying with the program described in ISO 9001-2000, or similar system.
2. PLB CONTRACTOR shall install all works to the satisfaction of the Project Manager, Employer, and inspecting authorities having jurisdiction.
3. PLB CONTRACTOR shall notify the Project Manager in writing of any instances in the Specifications or on the Drawings that are in conflict with any of the a forementioned authorities. All costs arising from performance of any work contrary to such laws, rules, or regulations without notice, are to Contractor's account.
4. Bring all deviations from the Drawings and/or Specifications required for conformance with the applicable codes and/or laws to the attention of the Project Manager. Correct all such deviations in accordance with the Project Manager's direction.
5. Applicable codes and/or laws govern minimum requirements only. Where the Drawings and/or Specifications identify materials, design details, etc., that are in excess of the code requirements, the Drawings and Specifications govern.
6. Notify the Project Manager of any scheduled testing at least 10 days prior to the test date. Provide the Project Manager with the option to witness any factory and field tests. The Project Manager reserves the right to conduct factory inspection at any time prior to shipping of equipment from the manufacturer.

B Mock-ups: Build mock-ups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups of typical PLB that will be used in the project, according with the Drawings.
2. Build mockups for demountable partitions including accessories of each type of exposed construction, corner, door and frame, glass and frame and accessory panel.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Owner specifically approves such deviations by Change Order.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

C Codes, Regulations, and Reference Requirements: The following codes, standards, and regulations cover the design, general hardware, construction, and quality control requirements for the PLB and associated components and systems. Other equivalent international standards are acceptable, subject to Project Manager's acceptance. Unless otherwise indicated, the latest edition of the following codes and standards apply to the extent indicated herein:

No.	Reference	Description
a.	EN 12312-4 latest edition	Aircraft ground support equipment – Specific requirements - Passenger Loading bridges.
b.	ICAO	In particular Annexes 14 and 17 l– latest Edition– Aerodromes.
c.	IATA	AHM (particularly AHM922) and ADRM latest Editions
d.	ICAA	International Civil Airports Association
e.	CARs IX	General Civil Aviation Authority. Civil Aviation Regulations
f.	EN 1915-1	*Aircraft ground support equipment - General requirements - Part 1: Basic safety requirements*
g.	EN 1915-2:2001+A1-latest edition	Aircraft ground support equipment. General requirements, Stability and strength Requirements, calculation and test methods
h.	EN 1915-3	Aircraft ground support equipment – General requirements, Vibration measurement methods and reduction
i.	EN 1915-4	Aircraft ground support equipment – General requirements, Noise measurement methods and reduction
j.	NFPA– latest edition	National Fire Prevention Association - NFPA 415 (latest edition), when Glass PBBs are used add the following sentence: “except clause 6.4.2”

No.	Reference	Description
		Referenced Standards such as NFPA 101, shall be governing codes for PBB
k.	ISO 9011	Quality Assurance
l.	EU 89/106	European Directive 89/106 – Construction Products
m.	DI 98/37/EEC	EN Directive Safety of Machinery
n.	DI 2004/108/EEC	EN Directive Safety of Machinery
o.	IEC	International Electro technical commission
p.	NETA	The international electrical testing association
q.	IEE	Institute of electrical engineers
r.	FEM	European Federation of Materials Handling
s.	IBC	International Building Code
t.	ADA	Americans with Disabilities Act

1.10 SUBMITTALS

A Product Data:

1. General: Submit manufacturer's data, specifications, and catalogue cuts. Include photographs or renderings of items exposed to view.
2. Submit the following product data, as applicable:
    a. Manufacturer’s nameplate data including product name, model, and manufacturer's name.
    b. Physical description, dimensions and weights.
    c. Foundation loads (forces and moments) imposed by the PLB for the anticipated range of rotation limits.
    d. Product properties, characteristics, capabilities and limitations.
    e. Data for coordination with other project work.
    f. Clear spaces required for handling, installing, operating and maintaining products.
    g. Required installation clearances and tolerances, and the location and size of openings or sleeves necessary for installation.
    h. Product specifications, including protective coatings.
    i. Information on any protective devices (e.g., stop blocks) or protective coatings that are applied to the equipment for protection during shipment that must be removed upon receipt at the Project site and prior to installation.
    j. Methods and details for anchorage to support rotunda foundation design and construction.
    k. PLB CMS system architecture, components datasheets and model number, operation and control philosophy, list of interfaces and data, interface control documents detailing interfaces with all third-party systems.

A. Shop Drawings:

1. General: Submit shop drawings including plan and elevation view layout for all work. Submit the following shop and erection drawings:
    a. Apron drive general arrangement including limits of bridge operations
    b. Foundation anchor bolt general arrangement, bolt design and layout.
    c. Foundation loads
    d. Anchor bolt installation
    e. Rotunda-FLB connection
    f. Support columns installation
    g. Rotunda assembly
    h. Tunnel assembly
    i. Cab assembly
    j. Lifting unit assembly
    k. Drive unit assembly

l. Service access and stairs assembly

m. Control console layout and details

n. Electrical panel and layout

o. Electrical cable conveyance system

p. Electrical schemes & wiring diagrams

q. Color schemes & selections

r. Lighting fixture catalogue data & controls

s. Proposed painting systems

t. Nameplate drawings

u. Communications and interfacing block diagrams

v. PLC controls including automatic vertical propositioning gate docking logic diagrams with interfacing signals provided from the aircraft docking system (ADS) provided by others.

w. Fire Alarm System connections and hardware.

x. PLB CMS control room layout, system architecture showing all control and monitoring components, cable routing drawings, panels layout and wiring diagrams.

2. Bill of Materials: Include bill of materials for major components.

3. Slope Calculations: Submit calculations tabulating the operating bridge slopes for each designated aircraft of the fleet mix by gate. Measure extended bridge slope length from the articulation point rotunda/ tunnel to the centreline of the levelled cab floor. Subtract a drop allowance for the tunnel ramp transition(s) in determining the total vertical drop. Include apron slope variations in the calculations.

4. Power Requirements: Submit itemized electrical power loads and demands for each PLB with the Proposal.

5. Drawing Certificates: Ensure shop drawings are certified by originator of work.

6. Structural Drawings and Calculations: Engage the service of a Professional Structural Engineer to carry out the design of the PLB structures. The Professional Structural Engineer shall endorse on the design drawings, calculations as well as the construction records.

B. Inspection and Test Reports:

1. General: Submit inspection and pre-operational test reports to demonstrate operability of the installed equipment. Provide documented statements of methods, procedures, results and evaluations prepared by Contractor, and/or installer, manufacturer or supplier, or independent consultants employed by any of these parties to indicate properties, characteristics and capabilities of a product or portion of the work.

2. Submit the following data with the inspection test reports:

a. Identification of product or work area represented by inspection or test.

b. Methods, procedures and results of inspections and tests, including observations of unusual conditions.

c. Evaluation of results, and acceptability and use limitations.

3. Certification: Ensure inspection and test reports are certified by organization that performed inspections, tests and evaluations.

C. Compliance Certificates:

1. General: Submit compliance certificates for the work in accordance with the following requirements.

2. Certification: Ensure compliance certificates are certified by the issuing organization.

3. Certificates Required: Submit compliance certificates for the following:

a. Design and fabrication of the PLB are in compliance with NFPA 415.

b. Equipment bearing the UL Listing Mark or equivalent nationally recognized independent testing laboratory, subject to acceptance by the Project Manager.

c. Any products not of the manufacturer's standard design, modified to suit these requirements.

D. Operation and Maintenance Data: Prepare and submit operation and maintenance manuals.

E. Maintenance Products:

1. General: Furnish maintenance products for all work required.

2. Delivery: Deliver maintenance products to the Project site 30 days prior to completion of the work. Unload, and place in storage as directed by the Project Manager.

F. Record Documents: Submit record documents in accordance with Section 01 00 00.

G. Refer to Division 27 Section "Common Clauses for IT, Security & Special Airport Systems" for applicable requirements related to PLB CMS

1.11 JOB CONDITIONS

A. Pre-Installation Meetings:

1. Primary: Conduct a pre-installation meeting at Project site prior to start of the construction/installation work. Include review of construction conditions, environmental requirements and coordination required for installation of the work, and responsibilities for temporary operation of permanent systems required for the work. Include in meeting invitees the Project Manager, installers of the work, and product manufacturer representatives, as necessary. Require PLB manufacturer to assist in working out conflicts, interferences, adjustment and responsibilities.

2. Other Work: When required, participate in other pre-installation meetings at the Project site to review conditions of other related project work. Assist in working out conflicts, interfaces, adjustments, and responsibilities.

B. Manufacturer's Representative: Furnish installation assistance of product manufacturer's factory trained representative to give installation instructions, assist in start-up operations, direct acceptance inspections and tests, and perform like services at Project site as required.

C. Structural Components: Do not cut, drill or weld existing structures, asphalt surfaces, or Apron concrete for attachment of PLB works without prior review and acceptance by Project Manager of each condition, except where specifically indicated on the Contractor Drawings. Submit requests for authorization in writing, designating specific extent and limits of work, and components proposed to be cut, drilled or welded.

D. Coordination: Coordinate PLB construction, installation, startup and testing work with Terminal and apron work in the vicinity. Coordinate details related to connection of PLB

to expansion joints, steel work, and foundations with the Employer and Terminal and other apron contractors. Any changes required in PLB work due to lack of coordination are to the Contractor's account.

1.12 SPARE PARTS

A. PLB CONTRACTOR shall provide spare parts that are required for the commissioning and start- up of the equipment.

B. PLB CONTRACTOR shall provide a quotation covering recommended on-hand spare parts for two years of continuous operation and a complete parts list with an illustrated parts breakdown or a cross-sectional drawings.

1. Information required with the recommended spare parts includes the following:

a. Part description, serial or part number, and price

b. Reference to assembly drawing

c. Total number of identical parts in the equipment

d. Number of on-hand parts recommended

e. Location and seller of stocked spare parts

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Provide all equipment and material new, undamaged, and of the best grade.

B. Where items exceed one in number, provide products with identical construction, model numbers, and appearance, from the same manufacturer.

C. Insofar as possible, provide products that are the standard and proven design of the manufacturer. Select manufacturer that has been engaged in the manufacture of the product for a minimum of 5 years. When standard products are modified to suit these Specifications, certify operating conditions, ratings and capacity of the product based on qualification tests and submit compliance certificates.

D. Acceptable Products: Certain makes and/or manufacturers of material and equipment are specified herein and/or indicated on the Drawings as acceptable products. Prior to submittal, use manufacturer's published data to verify that the product meets the requirements of the Contract Documents. Subject to acceptance by the Project Manager. Notify the Project Manager of conflicts.

E. Substitutions: Submit the specified materials and equipment. Where "or equal" products are specified, equivalent materials and equipment of other manufacturers may be submitted for consideration for acceptance by the Project Manager but must be clearly distinguished in the submittal as substitutions. Refer to Section 01 60 00 Product Requirements for protocol regarding substitutions.

F. Maintenance Products Required: Furnish the following maintenance products.

1. Special Tools: Two sets of special tools required for servicing the PLB mechanical / electrical works.

2. Touch-up finish paints and coatings: When major products are required to be factory finished, furnish four litres of each type and color finish coat paint applied

to product for field touch-up.

3. Jack stands and tow bar: Two sets.

2.2 PRODUCT SPECIFICATIONS

A. General Service / Product Requirements:

1. Design the PLB assemblies, together with the fixed loading bridges by others, to enable passengers to enplane and deplane, completely protected from the elements during normal or emergency operations while the aircraft is parked at the designated gate position. Accommodate all of the designated and alternate aircraft listed on the Schedules
2. Provide PLB assemblies including rotundas with supports, telescoping tunnel sections, cabs, drive assemblies, and controls. Furnish assemblies with complete wiring for power, lighting, communications, and other systems necessary for operation and interfaces with the building utilities provided by the Terminal Contract.
3. Provide complete PLB assemblies capable of telescoping, rotating about the vertical axis of the rotundas, and elevating and lowering the cab with independent cab rotation as specified and as necessary to serve the range of design aircraft specified for each Gate position. Ensure the total length of each PLB assembly in the fully extended position and in the fully retracted position meets the minimum requirements specified and shown.
4. Design the complete PLB assembly to be weathertight, both when sealed against an aircraft and when parked in any position with the weather door closed.
5. Design the complete PLB assembly to withstand / accommodate the environmental and design loading conditions as specified in Part 1.
6. For PLB components, including aircraft closure, flexible materials, seals, and other consumable parts that that are exposed to sunlight, select and use only UV-rated materials to minimize UV degradation.
7. Provide a new fire extinguisher, UL Listed, ABC Rated 3A:40B:C.
   c

B. Rotunda Assembly:

1. Make the rotunda assembly the Terminal end pivot for the PLB's vertical and horizontal motions. Design the rotunda assembly to rotate on a support column and to allow PLB rotation where specified and shown. Make the PLB rotunda assembly floor height fixed to match the fixed loading bridge floor elevation. Design the rotunda floor to remain stationary and level at all times and to provide a smooth transition between the fixed loading bridge and the telescoping tunnel section.
2. Design the corridor between the rotunda and the fixed loading bridge with a minimum inside clear width of 1.30 m and a minimum inside clear height of 2.10 m.
3. Make the rotunda assembly completely weathertight by means of suitable weather protection seals at connections to fixed and hinged tunnel sections.
4. Design the assembly such that the support column is not anchored or secured to the fixed loading bridge structure and does not transmit any loads (forces or moments) or vibrations to the fixed connecting components.
5. Design the rotunda assembly to allow the PLB to swing a minimum of 160 degrees;

80 degrees clockwise and 80 degrees counter-clockwise. Design the PLB to be capable of rotating sufficiently to allow the PLB to be positioned to the designated aircraft doors for any of the specified aircraft for gate positions as listed.

6. Limit the vertical tunnel slope from the rotunda to the aircraft door level(s) of any of the designated and alternate aircraft to 10% or less as per EN12312-4:2014

7. Fabricate the rotunda rolling wall slats using hot-dipped galvanized steel and finishes.

8. Provide adjustable slope, over-travel, and operational swing limit switches at the rotunda assembly. Make slope limits adjustable for both up and down slopes.

9. When the adjustable over-travel swing limit switch is actuated, cut off all control power so that the bridge can be moved only by using an emergency bypass switch provided on the control console. Equip rotunda frame with suitable mechanical stops (e.g., rubber bumper type stops) to prevent collapse of the telescoping tunnel sections.

10. In addition to the bridge swing limit switch, provide suitable controls to sound an adjustable warning buzzer at the control console prior to actuation of the over-travel swing limit.

11. Provide an electrical distribution panel to be mounted on the rotunda column. Provide in this panel the electrical disconnects, circuit breakers, and transformers needed to adapt the Terminal power to meet the PLB and attaching gate equipment electrical requirements. Provide a NEMA 4X enclosure made of steel material properly anti-corrosion treated and electrostatic coated for the control panel.

12. Design the rotunda support sole plates and foundation anchor bolts to match the rotunda foundation pedestals as provided and as shown.

C. Telescoping Tunnels:

1. Provide the tunnel portion of the PLB with 3 telescoping tunnels, rectangular in cross section, with largest cross section located adjacent to the aircraft.

2. Design development of the tunnel section(s) to attach to and be supported by the rotunda at one end and supported by a drive column at or near the cab end. Provide the drive column with a means to raise and lower the cab and thus vary the slope of the telescoping tunnel section as necessary to service the aircraft.

3. Make tunnel section wall and roof construction of steel framing with exterior flush glazing side wall panels, to suit PLB CONTRACTOR standard.

4. Furnish tunnels complete with factory installed lighting, insulation, and all inside /outside floor, walls, and ceiling/roof finishes as specified herein, suitable for the stated tropical humid and saline environmental conditions.

5. Provide transition ramps to accommodate the difference in elevation where tunnel sections overlap. Design development of the ramp to slope over a sufficiently large tunnel length to minimize the slope severity.

6. Provide the following minimum interior clear dimensions:

a.	Minimum Width: glass sidewall)	1.5 m (glass sidewall to
b.	Minimum Interior Height:	2.1 m (Floor to Ceiling)
c.	Minimum Inter-tunnel Ramp Width:	1.4 m
d.	Minimum Corridor Width:	1.3 m

7. Maintain clearance between tunnel sections where movement is necessary for the operation of the PLB. Protect openings between tunnel sections with suitable seals

such that the tunnel sections are weathertight. Ensure that the seals prevent ingress of fumes and hydrocarbons as far as reasonably practicable

8. Equip the telescoping tunnels with an under-mounted electrical cable conveyance system of PLB manufacturer's standard design. Ensure the system is accessible to maintenance personnel.

9. Provide tunnel rollers with sealed bearings.

D. Glass Wall Panels and Exterior Envelope:

1. Provide bridge tunnel walls constructed of flush-mounted glazing with internal steel framing. Match color, type of glazing including window trims, if provided, used in the design of fixed loading bridge as follows:

2. Glass: Meet NFPA 415 fire ratings.

3. Glass to match FLB curtain wall glass (visual appearance). Refer to drawings for the following systems and glass types that shall be matched:

   a) FLB Vision glass: EWS 115 (GL01c)

   b) FLB Spandrel Glass (shadow box): EWS 115 (GL02c)

   c) Rotundas Spandrel Glass (shadow box): EWS 124 (GL02e)

   d) The Glass color is neutral/light greenish as mentioned in the spec section 088000 "Glazing", for the above-mentioned glass types.

4. Metal panelling to match FLB metal panelling colour and finish.

   a) Rotundas cladding: EWS119 (FLB's Solid Cladding)

5. Depending on the Passengers Loading Bridges Locations, Contractor shall consider metal/finishes color that are similar to the following buildings' exterior finishes colors:

   a) The color adopted for all curtain walls structure/elements, whether they are steel or Aluminum, is RAL 9016 (white)
   b) The Standing Seam roof color (including bullnoses) adopted is RAL 9001 (SRI 88)
   c) The ACP cladding (EWS 116) color is RAL 1013
   d) The ACP soffit cladding (ESS 301) color is RAL 9016 (white)
   e) The cladding color of the BHS & Staff Entrance buildings is RAL 1013

6. Contractor shall submit:

   a) Method Statements
   b) Shop Drawings and Materials' Samples
   c) Colors, finishes samples, and mock-ups for approval and agreement of the Project Manager before commencing with Works. If any discrepancy of any sort is found, the Contractor shall inform the Project Manager and propose and coordinate the solution.

7. The Contractor shall coordinate all elevations with skin details and specifications and present all necessary shop drawings in conjugation with approved materials, for the Project Manager's review and approval.

8. for glazing types, refer to spec section 088000 "Glazing". Color of glazing is as specified. Provide sample for Project Manager's approval.

E. Service Access

1. Provide a service stair, landing, and service door at the cab, where possible.

2. Ensure that the stair is functional at all heights and positions of the PLB. Support

the bottom of the service stairs on wheels and make moveable with the PLB.

3. Locate the service access on the right side of the cab end of the bridge, where possible. Design the service access to provide access between the PLB and the Apron for authorized personnel. Locating the service access stairs on the left side of the cab to meet layout requirements.

4. Provide a service door of commercial grade steel with laminated half window, which meets or exceeds the 3/4 hour fire rating per ASTM E152. Ensure that the door size can accommodate a 1.9 meter tall person. Design the door to open to the service stairs and equip the door with a commercial-type hardware, automatic door closer. Equip each door with an electrically-operated door lock, door contacts and provisions for local door alarms and remote annunciations. Provide pathway for wire or cable to operate the door lock. Door access control, including card readers with PIN on both sides of each service door, will be installed by the Access Control System contractor. Provide a stainless steel kick plate covering the lower portion of the inside surface of the access door.

5. Design the service door to open outward onto the service stair landing. Make threshold flush with PLB floor without any tripping hazard.

6. Make the entire service stair assembly of hot-dipped galvanized steel construction with non- skid treads. Make all steps of equal depth and rise.

7. Protect the service stair with handrails on each side, designed to comply with OSHA standards.

F. Cab:

1. Design development of the cab to rotate a minimum of 120 degrees; a minimum of 90 degrees counterclockwise and 30 degrees clockwise relative to the tunnel section centerline(and 90 degrees clockwise and 30 counterclockwise, whenever the PLB is a left sided one). Provide limit switches and physical stops to control the rotation limits.

2. Provide the cab with a forward facing control console. Locate the console behind laminated glass windows to allow the operator a full view of the aircraft. Provide windows to the left, in front of and to the right of the operator.

3. Make cab wall slats of hot-dipped galvanized steel and finishes.

4. Provide a roll-up (coiling) aluminum door (which can be latched open or closed) with a key lock. Provide a cab restraint safety chain to be used when the weather door is open and the PLB is not docked.

5. Provide a full width spacer bar at the aircraft end of the cab floor. Ensure the spacer materials are flexible and non-abrasive to prevent scratching or other damage to the aircraft and meet NFPA 415. Provide built-in pressure sensitive switches in the space bar to prevent excessive pressure against the aircraft and to disable the forward movement of the PLB.

6. Equip the aircraft end of the cab with a cab floor that adjusts the level to horizontally align the cab floor with the aircraft doorsill. Make the floor individually actuated and independently adjustable to adapt to all aircraft doorsills and to provide a level surface adjacent to the aircraft doorsill for all PLB slopes. Ensure the transition floor presents no tripping hazards for the passengers.

G. Electrical Work:

1. General: Include wiring, raceways, starters, relays, switches, transformers, control devices, lighting fixtures, and telephone set.

2. Electrical Interface: Provide an interface at each gate position consisting of a Terminal contractor-installed switchboard for power supply to the PLB contractor-

installed interface junction box for communications, data, and fire detection systems. Install the interface junction box at the rotunda support column.

3. Power: Connect the main feeder for each gate to a dedicated circuit breaker at the Terminal contractor-installed interface switchboard. Provide distribution panel board with branch circuit protections and transformers for all other required voltages.

4. Grounding: Interconnect cab, tunnel sections, service stairs and landings, rotunda, and all electrical items including the attached gate equipment by a continuous grounding conductor. Provide the main grounding conductor with the power supply feeder.

5. Interior Lighting: Provide LED interior lighting, emergency lighting and exit signs with necessary drives. Provide lighting sufficient to produce an average light intensity of not less than 200 lux measured at 0.2 meter from the floor level.

    a. Provide interior lighting fixtures comprising a lateral lighting system installed in the upper right corner of the tunnels along their entire length to ensure the specified lux level. The number of the luminaires required will depend on the length of the tunnel sections.

    b. Provide cab lighting by means of two LED, downlights, with two LED in each.

    c. Provide rotunda lighting by means of the luminaires installed at the tunnel near the rotunda.

    d. Provide the luminaires installed at the transition points of the bridge (at rotunda end of the tunnel, at the ramp between tunnels, and at the cabin) with a 60-minute battery pack in case of main power interruption.

    e. Provide emergency lighting to illuminate at least 10.8 Lux measured at the floor level. Emergency lighting are arranged so that the failure of any single lighting unit does not result in an illumination level of less than 2.2 lux in any designated area, in accordance with NFPA 101. Emergency lighting shall be connected to ECBS outlet supplied from Rotunda ECBS.

    f. Provided Approved signs in compliance with local civil defense requirements to mark exits and exit access. Directional signs are placed at locations where the direction of travel is not obvious. Emergency lighting shall be connected to ECBS outlet supplied from Rotunda ECBS.

    e. Other bridge manufacturer's standard designed lighting fixture system will be acceptable, subject to acceptance by the Project Manager.

6. Exterior Under-Bridge Lighting: Provide three floodlights for each PLB. Direct two lights forward to illuminate the apron and aircraft. Direct one light to illuminate the drive column. Locate and protect the lights from damage due to operation of bridges or passing vehicles.

7. Communications System: Provide a telephone set and two data ports for voice and data transport at or near the PLB control console. For each PLB, provide and install:

    a. Cat 5e cables for phones and data transport.

    b. One telephone set and two data ports as indicated above.

    c. All necessary raceway for the Cat 5e cables, extending from the interface cabinet (on the rotunda column) to each data port.

    d. Data ports compatible with airport Ethernet TCP/IP communications.

    e. Communications interface suitable for connection to the airport BMS by others.

f. Communications interface compatible with the Control & Monitoring System (CMS), Visual Docking Guidance System (VDGS) and Building Management System (BMS) by others.

g. Pathway for cable and wiring to operate and annunciate door status.

8. Warning System: Provide the following safety devices / indicators:

a. Flashing warning beacon mounted under the cab. Design this beacon to flash when the PLB console power is turned on indicating that the PLB may be moving or may be moved at any moment.

b. Audible warning bell mounted under the PLB. Design this bell to ring to notify ramp personnel when the PLB is moving.

9. Convenience Receptacles: Provide a minimum of two convenience electrical outlets (240 VAC, 50 Hz, 1 Phase) as follows:

a. One at or near the control console or on the left wall adjacent to the control console

b. One at the rotunda end of the PLB.

10. Power Cables: Make power supply cables from the power interface switchboard underside- mounted.

11. Landing Light: Provide a LED lighting fixture with above the landing of the service access. Light may be photocell controlled or on-off controlled from the control console.

12. Closed Circuit TV (CCTV): Provide CCTV camera and LCD monitor to show apron area near the PLB drive wheels. Mount monitor on the control console.

13. Smoke Detectors: Provide smoke detection sensors as required. Provide alarm signals to the Fire and Smoke Detection System of the terminal (by Terminal Contractor) through dry contacts in the junction box on the rotunda support column.

Provide access control system and interface it with the main system in the terminal building.

H. Control Station:

1. PLB CONTRACTOR shall locate the control station on the left side of the cab and orient to position the operator facing forward in full view of the aircraft during the maneuvering and docking operations.

2. PLB CONTRACTOR shall provide a TFT display at the control console for control interfaces, indicators, and messages as required to support the functions. Accomplish all bridge motion (vertical, horizontal, and cab rotation) with switches / controls not located on the TFT display.

3. PLB CONTRACTOR shall make all bridge motion controls momentary contact type (deadman) pushbuttons. PLB CONTRACTOR shall employ appropriate ergonomic controls
/ layout for clarity /simplicity of operations (e.g., for raise and lower functions; physically locate the “raise” pushbutton above the “lower” pushbutton, etc.)

4. PLB CONTRACTOR shall include, as a minimum, the following controls:

a. A keyed switch which may be set to “AUTO”, “OFF” or “ON”. Design development of the controls to the require switch to be unlocked with a key prior to selecting “ON”, and for the key to be removable only with the switch in the “OFF” or “AUTO” position. Arrange circuitry to activate the automatic leveling system when the control station is turned to the “AUTO” position.

b. Single lever arm, “joystick”, to control horizontal PLB motions.

c. Controls for raising / lowering the cab end of the PLB.

d. Controls for left / right cab rotation.

e. Controls for operating the cab closure.

f. Controls for operating the adjustable portion of the cab floor.

g. Emergency Stop pushbutton for disconnecting all PLB operations.

h. Controls for operating the service landing light.

i. Controls for switch on / off the PLB self-contained HVAC systems (Roof top).

5. PLB CONTRACTOR shall provide the following mechanical and/or logic interlocks to prevent damaging control circuits or PLB components, or injuring personnel:

a. Design development of the controls so that selection of the "OFF" position by the operator disables all basic bridge controls.

b. Bridge motion detection sensors interlocked with bridge motion controls incorporating two levels of limits. First level limit to provide warning to the operator

and interrupt the specific problem motion only. Second level limit to prevent physical travel that may damage the PLB or potentially endanger personnel.

c. In addition to the electrical/instrument interlocks, PLB contractor shall provide positive mechanical stops to prevent overtravel of the PLB and individual tunnel sections, over-rotation of the cab or rotunda, and to limit cab up and down motions within pre-set limits.

d. Lock bridge drive out of operation when aircraft closure is fully extended.

e. Bridge-mounted proximity type anti-collision devices to sound alarm and lock out bridge drives upon activation.

6. Illuminate the control console and its surrounding area with adequate lighting for operational and maintenance functions to be carried out.

I. Aircraft Closure:

1. Equip the aircraft end of the cab with a folding bellows aircraft closure. Design the closure such that, when fitted against the fuselage, it surrounds both the open aircraft door (for swing- out type doors) and the doorway to protect passengers from the elements. Design the closure covering to remain flexible and accommodate the environmental conditions as specified, to be waterproof, and to be highly resistant to punctures and tearing.

2. Equip each side of the aircraft closure with a canopy drive to make each side independently adaptable to the aircraft fuselage.

3. Incorporate into the closure mechanisms pressure safety devices to prevent excessive pressure on the aircraft.

4. Provide contacting seal or seals in the aircraft closure with a soft material to prevent scratching or other damage to the aircraft. Make the seals that contact the aircraft easily replaceable.

5. Enclosure shall meet NFPA 415.

J. Automatic Leveling:

1. Equip the PLB with an automatic leveling system that permits the PLB to follow small changes in aircraft doorsill height automatically. Design development of the

system to function with the same reliability for all specified aircraft regardless of door location or fuselage contour.

2. Provide the following control functions:

   a. Design development of the auto-leveling system to engage when the "AUTO" mode / control is selected at the control console. Design the automatic leveling arm actuator motor to extend the arm to the aircraft when "AUTO" position keyed switch is selected and retract automatically when "ON" position is selected.

   b. Display the auto-leveler position at all times by means of a message on the control panel display.

   c. Design development of the system so that, if the auto-leveler arm fails to make effective contact with the aircraft when the "AUTO" mode / control is selected, an alarm is actuated and a message is displayed to notify the operator.

3. Provide a contact controlled "safety shoe" type device as a back-up feature to the auto-level system. Plug the safety shoe into an electrical receptacle provided in the cab near the control console. Design the system so that in the "Automatic" operation mode, the safety shoe is placed under the open aircraft door, and in case of contact with the aircraft door, the PLB is automatically lowered and an alarm is actuated.

K. Drive Column:

1. Design development of the drive column to provide for both vertical and horizontal motion of the PLB, with the range of motion adequate to serve the specified types of aircraft. Design the drive column and control systems for smooth, quiet operation. Design vertical and horizontal drive systems to operate independently of each other, however, restrict all PLB motion, with the exception of the vertical drive system, when the PLB is in the auto level mode of operation.

2. Design development of the PLB to be moved vertically by two hydraulically-actuated assemblies.

3. Hydraulically Actuated System: Provide a hydraulic power pack and two cylinders. Equip the hydraulic drive assemblies with non-return valves to hold securely without creep at each elevation within the range. Make the vertical brakes fail-safe, to apply automatically in the absence of power.

4. Make each assembly capable of supporting the PLB under full design load for 100% redundancy.

5. Move the PLB horizontally via a variable speed drive system.

6. Support the PLB on solid rubber tires.

7. Make the PLB vertical and horizontal movement speeds sufficient to allow the PLB to be safely and smoothly re-positioned from any starting point to dock at any of the specified aircraft door sills within two minutes. Make the vertical and horizontal speeds controllable within the following ranges:

   a. Vertical travel speed - lifting: 1.1 m/min minimum.

   b. Vertical travel speed - lowering: 1.1 m/min minimum.

   c. Horizontal travel speed - normal: 1.0 to 25.0 m/min.

   d. Horizontal travel speed - slow: 1.0 to 10.0 m/min.

8. Make the drive wheels independently driven, and provide each drive motor with integral brakes. Employ a dynamic braking system to allow the PLB to come to a smooth controlled stop. Design the brakes to lock the PLB in place when it is not being driven horizontally.

9. Equip the horizontal drive motors with a means to manually release the brakes to allow the PLB to be towed in the event of power failure. Provide tow lugs on the wheel frame.

10. Furnish motors used in the column drives as permanently lubricated type.

L. Interior Finishes:

1. General: Make the interior finishes of the PLB durable and easy to clean, proven to withstand the humid and hot environment and airport traffic. Subject to acceptance by the Project Manager /Client, provide the following features:

2. Ceiling:

a. Customized perforated metal ceiling system with powder coating finish.

b. Color: White, to RAL 9016.

c. Moldings for corners and top edge of wall panels, where provided.

d. Ceiling to match FLB ceiling system and finish.

3. Walls:

a. See wall glazing requirements in paragraph 2.2.D for exterior glass, with vision glass in the middle, and spandrel glass at bottom and top.

b. At Separation between two passages: Decorative glass type 08:GL20, heat-strengthened laminated ultra clear glass, as specified in Section 088113 “Decorative Glass Glazing”.

c. Interior Metal Cladding System, to match FLB metal cladding system and finish, fabricated from Stainless Steel (type 316), brushed satin finish.

4. Insulation:

a. Insulation meeting the requirements of NFPA 415.

b. Mineral wool pads: 60 mm thick at ceiling and floor

5. Subflooring:

a. Galvanized steel sheets.

6. Floor Finishes:

a. Carpet Tiles, Mist Greige color.

b. Carpet tiles to match FLB carpet tiles.

M. Exterior Finishes:

1. Provide exterior steel finish as indicated in the above Part 2.2-D, and meeting the client specifications.

2. Contractor’s shop-applied exterior coating systems as alternative substitutes will be considered, in case Contractor submits valid reasons in writing, subject to review and acceptance by the Project Manager.

N. PLB Ventilation and Air Conditioning:

1. Provide a means to pre-cool the PLB (either use of a separate bridge-mounted air-conditioning (A/C) unit or the use of the PCA Unit). Include ducting, controls and instrumentation, airflow diversion dampers, fittings, registers, etc., as necessary for

a "bleed system" from either the A/C or PCA unit to the tunnel sections of the PLB.

2. Design the system so that, in the event of an activation of a smoke alarm in the PLB, the PCA and exhaust fan are shut off automatically. The roof top units are shut off automatically.

3. Equip each PLB with an air-conditioning system. The system shall consist of bridge-mounted air conditioners, HVAC ductworks, registers, diffusers and independently operated controls and thermostats to allow for an even and uniform distribution of the conditioned air throughout the tunnels (assuming the constraints attached to the telescopic movement). Integration of the bridge mounted air conditioners to the bridge assemblies shall be aesthetically pleasing and compatible with the bridge designs. The final design and layout of the PLB air conditioning system shall be subject to review and acceptance by Employer and Project Manager.

   a. The air conditioning system shall be capable of pre-cooling and maintaining a summer temperature of 25º C with 50% Relative Humidity maximum in the PLB.

   b. The air conditioning system shall be capable of reducing the PLB interior space temperature of a heat-soaked PLB from 40º C to 25º C or lower on a summer design day in 15 minutes, with no occupants. The system shall be capable of automatically adjusting supply air temperature and flows under the specified design ambient conditions.

O. Equip each of the 400 Hz ground power units with an integral powered coil and storage. Refer to Spec No. 16211 for the cable coil storage requirements.

P. The condensate piping of the PLB air conditioning system shall be installed and connected to the MTB drainage system.

Q. Diagonal Truss

1. Provide double diagonal (x-shape) truss.

R. Diagonal Truss

1. In lieu of a single diagonal steel truss in glassed walls, provide double diagonal (x-shape) truss.

2.3 PASSENGER LOADING BRIDGE – CONTROL MONITORING SYSTEM (CMS)

A. SYSTEM ARCHITECTURE

1. The main functions of the PLB CMS shall be:
   a. Monitoring of the status of the aircraft stands and their equipment.
   b. Reporting stands availability.
   c. Informing the Resources Management System of aircraft effective arrivals and departures.
   d. Reporting of stand equipment use for billing purposes.
   e. Lock a PLB for maintenance purposes (usually in case of failure of one component of the PLB).
   f. Management of PLBs Users login and long term storage of the PLBs data storage.

2. The PLB CMS centralizes the data available for equipment such as the passenger loading bridges (PLB), associated air handling units (AHU), the pre-conditioned air (PCA), the 400Hz, and the water supply system.
3. All the data shall be diagnosed to determine stand availability. Unavailability of a stand shall be reported to the Resources Management System (RMS). In case of restriction of use of an aircraft stand, the diagnostic shall also indicate the duration

of the restriction (beginning and end time), as well as a free text to indicate the cause of the unavailability. A pre-set time is reported to the RMS in case of stand unavailability.

4. The PLB CMS shall provide the PLBs with the aircraft type expected on each aircraft stand, as well as the estimated arrival and departure time, the flight number and the stand allocated for the flight. The information shall be supplied by the Management Information System (MIS) and shall be used to prepare the stand for the next incoming aircraft.
5. Information concerning equipment usage and consumption shall be available at the PLB CMS, for billing calculation and invoices issued to airlines by the Billing System. The aircraft presence at the stand (block ON, block OFF) needed by the billing system shall be collected from the MIS.
6. Stand equipment unavailability shall be reported to Airport Management Information System MIS shortly before an aircraft arrival (user configurable time).
7. The Airport Master Clock sets all the equipment of the PLB CMS to the same date and time.
8. The system shall interface with the following equipment:
    a. Passenger loading bridges (PLB)
    b. Pre-conditioned air (PCA) system and associated pits
    c. The water supply system
    d. 400 Hz and associated pits
    e. Water supply System
9. In addition to the above integrated systems, the PLB CMS shall interface with the following systems:
    a. The Resources Management System (RMS)
    b. The Management Information System (MIS)
    c. The Billing System
    d. The Master Clock System
10. Communication with the RMS, MIS, the Billing System and the Master Clock shall occur through the Master System Integration (MSI).
11. Dedicated PLB CMS Spaces:
    a. Operations Room to include the Operations workstation.
    b. Maintenance Room to include the Maintenance workstation and printer.

B. SYSTEM REQUIREMENTS

1. The System shall be a Commercial off the Shelf (COTS) product utilizing the latest hardware and software technology and shall be based on an open architecture.
2. Data provided by 3rd party systems must be stored in a fault tolerant manner within the application.
3. Systems which maintain historical data must maintain appropriate static tables to enable accurate historical lookups.
4. The system shall provide management capabilities to support problem, alert and performance monitoring, configuration management and access control.
5. The system shall have maintenance reporting tools to notify the operator of any System failure.
6. The system shall provide comprehensive maintenance and configuration management tools including support for remote system management using VPN provided by others.
7. The system shall be installed with the recommended RAM capacity indicated by the software manufacturer.

8. System shall be integrated into a Virtual Environment, all requirements in terms of CPU, RAM, network bandwidth, backups and storage capacity shall be well taken care of and properly implemented in the system.

C. System performance requirements

1. For calculations purposes the virtual environment shall be considered with 100% availability.
2. Unless otherwise stated system availability shall be better than 99.99%.
3. Maximum time to display information on the operator workstation screen is 10 seconds.

D. System Design

1. The Contractor shall coordinate the design with the Project Manager and Authorities and shall accommodate the changes in specifications, design, etc…, if any before final approval, with no additional cost to the Client within context and intent of this section.
2. The contractor shall provide the latest proven technology (hardware and software) from reputable A-Brand manufacturers,
3. General System Design Requirements
   a. The Contractor shall provide a complete single line diagrams for the system
   b. The system shall be capable to be installed on a virtual server
   c. All components of the system shall have the exact same time. The System time shall be synchronized through the network by the NTP time server of the Master Clock System.
4. As the Airport is planned to have a steady growth rate the following shall be considered in the design of the system:
   a. Support of increasing number of user groups and stakeholders
   b. Support increasing number of airport resources, buildings and assets
5. Any failures shall be logged and viewable at a central point on the Network Management Administration Console.
6. The System shall fully support remote management
7. The System shall report, but not limited to Applications hardware status (e.g. Hardware, Storage, etc.), Workstation status, Field Device status and Network status
8. The System shall support configuration management and software updates from a central point.
9. The system storage calculation shall consider data, logging, archiving, growth (increase in number of devices) and 25% spare,
10. All PLB CMS components shall be connected to the converted network of the Airport.

11. It is the PLB contractor responsibility to provide a full solution including the VM server configuration and coordination with the ICT contractor.

E. DEVICES AND COMPONENTS

1. PLB CMS shall be consisting of the following equipment:
   a. Two (2) workstations with monitor minimum 27", one workstation (operator workstation) will be located in the TOCC room in the MTB and one workstation (maintenance workstation) will be located in the PLB/VDGS maintenance room.
   b. Two (2) redundant Servers (one server located in the Administration

Building and one server located in the Datacentre building),
c. Two (2) industrial tablets
d. One laser printer
e. All needed items for the proper operation of the system

2. The workstations/servers shall be selected according to the PLB CMS performances requirements and considering the specifications listed herein. Configuration and brand shall be submitted to the Project Manager's approval. They shall be selected according to the printers used for the project.
3. Industrial Tablet: two(2) wireless Industrial Tablets, with the following characteristics, not limited to Latest compatible operating system, 10.4" mini anti-reflective, scratch proof display, Minimum 2GB RAM, Must weigh less than 1.5 kg (Including battery), Support IEEE 802.11 b/g/n/ac, Support EAP/LEAP network authentication and WPA2 security, Weatherproof, rugged and robust (IP 64 standard minimum, IP67 preferred), withstand vibration levels of 10-100Hz with 2g for 1 hour, Withstand repeated drops of at least 1.6m onto concrete, Operating temperature should be between -0 C and +50 C, The Supplier should deliver the mobile terminals with appropriate accessories such as a holster & strap, protective covers and recharging devices
4. Printer: One Laser Printer, HP or equivalent. Printer to be selected according to the printers used for the Project in coordination with the relevant Contractor

F. PLB CMS Operations Workstation

1. Summary
   a. This workstation shall be used by the Operator(s) in charge of the PLB CMS.
   b. The PLB CMS Operator shall have the possibility to:
      1) Monitor all the operations made on any of the PLB and associated stands equipment
      2) Monitor all operational alarms
      3) Monitor all critical alarms affecting the availability of the aircraft stand
      4) Monitor stand availability
      5) Specify type of equipment failure or type of work carried out on the stand
      6) Specify duration of unavailability or restriction of an aircraft stand
   c. The Operator shall be able to manually input information to the system concerning the aircraft stand availability:
      1) PLB cleaning in progress
      2) Apron cleaning in progress
      3) Preventive maintenance in progress
      4) Repair work in progress
      5) Use of equipment forbidden
      6) Estimated duration of unavailability or restriction
      7) Free text to enter the reason of stand unavailability
   d. The stand availability shall be defined according to the type of equipment failure.
      1) Aircraft stand is available
      2) Aircraft stand is available with restriction: at least one equipment of the aircraft stand is failed, but the stand can still be used (the PLB CMS operator shall be able to type a free text to provide additional information on equipment unavailability)
      3) Aircraft stand is not available
   e. The PLB CMS shall have an interface with:
      1) The MIS, to automatically display stand allocation information and details on a flight expected at an aircraft stand.

2) The RMS, to report stand's availability, PLB availability and block ON / OFF information in real time, so that the RMS can update the stand allocation system. PLB mode is also reported to the RMS.
3) The Billing System, to report operating information on ground equipment necessary for invoices.

f. The PLB CMS Operations Workstation location shall be coordinated between PLB CMS Contractor and End Users.

2. Functions
   a. The PLB CMS Operations workstation shall have the following screen views:
      1) Overall stands view
      2) Aircraft stand views
      3) Stand availability view
      4) Alarm page
   b. A menu bar shall be displayed on all views that allows the users to switch from one view to another, at any time. Date and time, as well as the name of the currently displayed view, shall also be displayed on all views.

3. Main view
   a. An overall view shows all the aircraft stands**.** This view shall be automatically displayed on startup of the system.
   b. The view shall include:
      1) An overall view showing stand's availability. A colour coding shall be used to indicate the status of the stand:
         - Green to indicate the stand is available
         - Red to indicate the stand is currently not available: equipment failure / repair / use forbidden
         - Orange to indicate a minor problem on the stand: at least one equipment on the stand is not available but the aircraft stand can still be used
         - An indication shall be available to show if an aircraft is docked at the stand (aircraft shown at the relevant aircraft stands).
      2) An alarm band showing the last alarms of the system.
      3) A selection to enter the aircraft stand number to display on screen.

4. Aircraft Stand Views
   a. One view shall be available for each aircraft stand, showing aircraft stand equipment availability.
   b. A color code shall be used to indicate the status of the equipment:
      1) Green to indicate the equipment is available
      2) Red to indicate the equipment is currently not available: failure / repair / maintenance in progress
      3) Orange to indicate a minor problem on the equipment
   c. The aircraft stand view shall allow access to equipment views, one for each type:
      1) One view for each PLB, with access to more detailed views showing information on the rotating system, levelling system, the lighting, the sensors, the safety shoe, etc.
      2) One view for the 400Hz, including the information concerning the pits (open / closed).
      3) One view for the PCA and the Water Supply Equipment, including the information concerning the pits (open / closed).
      4) One view for the bridge AHU as applicable.

   d. Each view shall display, on pop-up windows if necessary, all relevant

information concerning the various equipment of the aircraft stand.

5. Alarm View
   a. Only operational alarms and critical equipment failures shall be reported to the Operations unit. The associated equipment shall be displayed in color on the detailed view of the relevant stand. All active alarms shall be listed on the alarm page in chronological order, with the oldest alarm at the top of the page. Each alarm shall have a date and time stamp and have a brief description. The alarm text shall be clear for easy understanding by the Operator.

6. Stand Availability View
   a. The PLB CMS Operator is in charge of informing the RMS of the status of aircraft stand equipment.
   b. In case of equipment failure or when maintenance or clean-up work is required, the PLB CMS shall be able to input this information in the system, to indicate scheduled work on a stand.
   c. The PLB CMS Operator shall manually input data in the system, such as:
      1) Scheduled repair on a stand or the apron area associated to a stand
      2) Scheduled clean-up work on a stand or the apron area associated to a stand
      3) Estimated duration of unavailability
   d. The type of unavailability shall be chosen by the Operator in a pre-defined list. A more detailed explanation on the cause of unavailability can be typed if necessary.

B. PLB CMS Maintenance Workstation

1. Summary
   a. The maintenance workstation of the PLB CMS shall be used for the maintenance of the aircraft stand equipment. Special consideration should be made to make use of an industrial wireless terminal tablet to provide access to any stand.
   b. This unit shall consist of a workstation and a printer.
   c. The maintenance crew shall have the possibility to monitor information regarding all the aircraft stands:
      1) All the operations made on any of the PLB (and associated equipment, such as PCA, PLB air conditioning, water supply and 400Hz)
      2) All operational alarms
      3) All critical alarms affecting the availability of the aircraft stand
      4) All alarm and information regarding the equipment
      5) Communication failures
      6) Specify type of work carried out on the stand
      7) Specify duration of unavailability or restriction of an aircraft stand
   d. To this effect, the system shall communicate with every PLB, PCA, PLB AHU, 400Hz and water supply systems.
   e. The maintenance Operator shall be able to enter information to the system concerning the maintenance task carried out on the aircraft stands:
      1) Preventive maintenance in progress
      2) Repair work in progress
      3) Estimated duration of unavailability or restriction
      4) Free text to enter reason of stand unavailability
      5) PLB availability status, etc.
   f. The Maintenance workstation location shall be coordinated between PLB CMS Contractor and End Users.

2. Functions
   a. The PLB CMS Maintenance workstation shall have the following views:

1) Overall view, as described for the Operations Workstation
2) Aircraft stand views, as described for the Operations Workstation
3) Alarm page, as described for the Operations Workstation

4) Network view
5) Aircraft database update view
6) Maintenance schedule view
7) PLB data storage
8) PLB users login and password management.

b. A menu bar shall be displayed on all views to switch from one view to another without navigating to a main view at any time. Date and time, as well as the name of the currently displayed view, shall also be displayed on all views.

3. Network View
   a. The network view shall display the status of the communication between the various components of the PLB CMS System.
   b. Interfaces with external systems shall be displayed as well.
   c. A faulty link shall be displayed in a different color.

4. Aircraft Database Update View
   a. One view shall be available to allow the Maintenance Operator to update the aircraft database contained in the PLB.
   b. In case a new type of aircraft has to be added to the system, it shall be possible to update the database update remotely from the Maintenance workstation. In the same way, a type of aircraft may be deleted from the database.

5. Maintenance Schedule View
   a. The Maintenance Schedule View shall allow the maintenance Operator to print scheduled maintenance to be carried out on aircraft stands on a weekly basis.

6. PLB User login Management
   a. Login and passwords shall be used to authorize a dispatcher or a Maintenance Operator on a PLB.
   b. Login and password shall be entered on the PLB touch screen and sent to the PLB CMS server for validation.
   c. It shall be possible to modify the Login and Password database from the server or using the Maintenance Workstation.

7. PLB Long term Data storage
   a. Data storage of the events logged in the PLBs shall be stored in the PLBs for short term then transferred to the PLB CMS server for long term storage.
   b. Data storage shall be able to be filtered and exported to the PLB Maintenance laptop using the Maintenance Workstation.

8. Printer
   a. The local printer shall be used to print:
      1) Sorted alarm list
      2) Preventive maintenance schedule
      3) Reports
      4) Status of an aircraft stand
   b. Alarm printing shall only be implemented from the Maintenance Workstation.

C. PLB CMS Servers

1. Summary
   a. The PLB CMS shall use a redundant server cluster that collects and stores data from the various aircraft stands, and provides monitoring units with relevant information on aircrafts stand status. PLB CMS servers shall be based on virtual machine (VM) type of environment and shall be located in two (2) separate locations.
   b. The main functions of the servers shall be the following:
      1) Interface with:
         - The GOS and Airport Operational Systems (RMS, MIS) through the MSI
         - The Billing System
         - The Airport Master Clock System.
      2) Supervision server
      3) Time synchronization
      4) Password management
      5) PLBs Users login and password management
      6) PLB long term data storage
      7) Alarm log
      8) Manage alarms for database capacity
      9) Data saving on external support

2. Functions
   a. Monitoring Server Function
      1) The monitoring of the PLB CMS workstations shall be managed from the Supervision server. The application data as well as the views and the real time database of the application shall be stored.
   b. Historical Data Save Function
      1) System data such as technical failures, operational failures and other data reported from the various components shall be logged in the server, with a date and time stamp.
      2) The event log files shall be saved on external support to avoid system overload (hard disk full).
   c. Data Save Function
      1) Shall allow data save on removable external support of selected files, in a format that can be used with MS Excel or Access.
      2) Shall allow removal of those files from the server after being saved. This action can only be done after Operator validation.
      3) These functions shall be activated manually by the maintenance Operator on the database server.
   d. Recovery Function
      1) In case of system failure, data might need to be reloaded in the system. Loaded data during the recovery process shall have the same configuration and same format as initially.
   e. Time Management
      1) In order to synchronize all the clocks of the system, the server shall be in charge of setting all equipment clocks with the Airport Master Clock's time.
      2) All the equipment of the PLB CMS shall be automatically synchronized to the same time and date by means MSI interface with the NTP server.
      3) Setting other equipment time shall be done at least once a day, and shall be done upon recovery from a communication failure.
   f. Password Management
      1) Passwords shall be used to access some functions of the system
      2) It shall be possible to modify passwords from the server; but this function shall be password protected.

g. Database Capacity Alarm
   1) Alarms shall be generated when the server capacity (hard disk) reaches a given level.
   2) Two levels can be set and modified. At implementation on site, they shall be set at:
      - Warning level: 85% used,
      - Alarm level: 95% used.
   3) These alarms shall be logged on the server.

h. PLB User login Management
   1) Login and passwords shall be used to authorize a dispatcher or a Maintenance operator on a PLB.
   2) Login and password shall be entered on the PLB touch screen and sent to the PLB CMS server for validation.

   3) It shall be possible to modify Login and Password database from the server or using the Maintenance workstation.

i. PLB Long term Data storage
   1) Data storage of the events logged in the PLBs shall be stored in the PLBs for short term then transferred to the PLB CMS server for long term storage.
   2) It shall be possible to filter data storage and export it to the PLB Maintenance laptop using the Maintenance Workstation.

D. PLB CMS APPLICATION

1. The PLB CMS Application will be installed in the Airport as an independent system.
1. The components of the PLB CMS Application shall comply with the requirements issued by the Contractor in charge of the Airport VM System in order to ensure that the Performances are met,
2. The supply includes all licenses, compatible software and hardware required to integrate the PLB CMS Application in the Airport VM,
3. Long term Storage shall be stored in an external data storage (NAS or SAN) supplied by the PLB CMS supplier,
4. System recovery will be achieving by the Airport VM, however the PLB CMS supplier shall manage the recovery of the data stored in external storage,
5. PLB CMS contractor shall coordinate with all related contractor for the Racks, switches, data sockets, SCN and CNE components

2.4 PLB CMS INTERFACE WITH THE PASSENGER LOADING BRIDGES

A. The PLB CMS shall have an interface with the PLBs at each stand.

B. Connections shall be established with the PLC of each bridge. The interface shall use MODBUS over TCP/IP with an RJ45 plug.

C. The Operator shall be able to access the following information on the PLB CMS control panel display:

1. Position of the PLBs
2. Aircraft type.

D. When the PLBs are correctly pre-positioned, the PLB CMS is informed and aircraft docking procedure can start.

E. The PLB CMS shall send the expected flight information to the PLB, as well as locking of any PLB for maintenance purposes (if one of the PLB components failed).

F. This interface shall allow reporting of all actions made at the PLB level, as well as reporting all operational and technical failures. In addition, it shall be possible to update the PLB aircraft database remotely, using this link.

G. Data reported from the PLB to the PLB CMS shall be listed by the Contractor and shall as a minimum include the following:

- PLB operating mode
- PLB position (angle and length)
- PLB external lights status
- PLB pre-positioning
- PLB height
- PLB internal lights status

- Anti-collision siren status
status
- Rotating system status
- Range of motor intensity measurement
- Excess of nominal current
- Over current
- Phase failure
- Temperature rise
- Oil level, if any
any
- Sensors status
- Operating time
- Control console failure
- Communication failure
- Emergency stop
- PLB positioned for expected aircraft
- Anti-collision flashing lights
- Range of control loop
- Breaks status
- Short circuit
- Voltage drop
- Phase sequence order
- Levelling system failure
- Hydraulic reservoir level, if
- Safety shoe status
- Emergency lowering
- PLC or computer failure
- Movement travel limit
- Hour meter
- Validation for PLB locking

H. The above list shall be validated during final design.

I. The beginning of the aircraft docking procedure shall stop all the PLB's movements for safety reasons. Once the procedure is finished (aircraft parked), PLB's movements are allowed after a safety time of about 10 seconds.

J. Cables running inside the PLB shall form part of the PLB Contractor’s Scope of work.

K. The PLB CMS Contractor shall be in charge of interconnecting the PLB CMS and the PLB through an Interface Box located in the stand Technical room (IT room located in the Building Rotunda).

L. The PLB CMS Contractor shall be in charge of connecting the PLB CMS to the network switch located in the stand Technical room (IT room located in the Building Rotunda).

2.5 PLB CMS INTERFACE WITH THE PCA, 400HZ AND WATER SUPPLY

A. The PLB CMS system shall interface with the PCA, 400 Hz and Water Supply systems of a PLB. The interface shall use MODBUS over Ethernet (TCP/IP) type, with a RJ45 plug.

B. The PLB CMS shall display the pit open status and shall prevent aircraft docking while the PCA pits are open.

C. Coordinate with PCA, 400Hz and Water Supply Contractors for details of interface with the PLB CMS.

D. The interface shall allow reporting of all actions made at the PCA and Water Supply level, as well as reporting all operational and technical failures. In addition, information on the status of the pit (open / closed) shall be reported to the PLB CMS.

E. Data reported from the PCA and the Water Supply to the PLB CMS shall be listed by the Contractor and shall include as a minimum the following:

- Water pumping stations status/Fault
- Water tanks levels
- Hour meter contact
- PCA general fault
- ON / OFF power status
- Coil condition
- Fan power variator fault
- Air valves position
- Manholes position
- Lifting pump working auxiliary contact
- Emergency stop
- Potable water flow meter
- Watt meter
- PCA working auxiliary
- PCA filter fault
- Control valves
- Blown air pressure probe
- PCA electrical fault
- Air valve position fault
- 400Hz cable extracted
- Lifting pump fault
- PLC or computer failure

F. The interface shall allow reporting of all actions made at the 400Hz system level, as well as reporting all operational and technical failures. In addition, information on the status of the pit (open / closed) shall be reported to the PLB CMS.

G. Data reported from the 400Hz system to the PLB CMS shall be listed by the Contractor and shall include as a minimum the following:

- 400Hz converter operating mode
- Emergency stop
- Auxiliary 48V voltage
- Power consumption meter
- Load Ampere in each phase
- Voltage across each phase
- Circuit breaker status for various 400Hz converter power supply

- Frequency

- Cable hoist
- Converter status
- Hour meter
- Pit position
- PLC or computer failure
- PLC or computer failure

2.6 PLB CMS INTERFACE WITH THE GATE OPERATING SYSTEM (GOS)

A. The PLB CMS shall have an interface with the GOS through the MSI.

B. Data reported from the PLB CMS to the GOS shall be listed by the Contractor and shall include as a minimum the following:

- VDGS operating mode
- Block ON / block OFF
- Control box status
- Communication failure
- Emergency stop
- Aircraft identity failure
- PLC or computer failure
- Stand status
- Display status
- Scanning unit status
- Main computer unit failure
- Hour meter
- VDGS low visibility mode status

2.7 PLB CMS INTERFACE WITH THE MASTER SYSTEM INTEGRATION (MSI)

A. Through the MSI, the PLB CMS server shall communicate with:

1. The RMS: to report the unavailability of the stand, with a beginning and end time, as well as a free text to indicate the cause of the unavailability. When an aircraft stand is unavailable, a preset time of unavailability is reported to the RMS.
2. The information about aircraft presence on stands (block ON, block OFF) is also reported. In the same way, the VDGS also informs the RMS about PLB unavailability and its mode (OFF, Manual, Auto levelling).
3. The MIS: to get flight information with the flight number, aircraft type, aircraft series, stand allocation for the flight, estimated arrival time and estimated departure time.
4. The billing unit: to report information on ground services such as the PLB, the 400Hz, the PCA and the water supply (for billing purposes). The information will be used for invoices to airlines.

    a. The block ON/OFF information needed by the billing system will be received from the MIS.

B. The interface with these systems shall be done through the Master System Integration (MSI) that centralizes all the data necessary to the various systems.

C. The interface between the PLB CMS server and the MSI shall be through Ethernet TCP/IP, via the redundant Airport data network backbone.

D. The full list of information exchanged with these systems shall be prepared and confirmed during the design phase.

E. The list of foreseen data exchanges is detailed in Annex A of Division 25 Section "Master System Integration (MSI)". The list is not intended to be exhaustive but is a foreseen list of information that should be exchanged between all interfaced systems.

PART 3 - **EXECUTION**

3.1 FACTORY TESTING

A. Inspect and test each functional assembly at the factory prior to shipment. Employer or his representative maintain the right to witness these tests. Provide a 10-day notification prior to performance.

3.2 INSPECTION

A. General: Examine the areas and conditions under which the work is to be installed or performed, and remedy any conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

B. Cutting and Patching: Inspect existing conditions of the work including elements subject to damage or to movement during cutting and patching. After uncovering work, inspect the conditions affecting installation of products, or performance of work.

C. The Contractor shall perform basic tests to ensure that the system and its components are functional. The results of these tests will be recorded and submitted to the Project Manager.

D. Prior to the inspection the Contractor is responsible to ensure a work area is ready and all requirements and pre-requisites have been met such as: health and safety, operation of mechanical and electrical systems, removal of construction equipment affecting the works, cleanliness of the area, etc.

E. The Contractor shall verify that the installed System is working and shall notify the Project Manager by letter. The Project Manager will inspect the installation and respond by letter indicating any issues or authority to proceed to next step

F. The Contractor shall record all inspection observations including the name(s) of personnel conducting the inspection, a brief description of the inspection and the observations. These records shall be available for review at any time and submitted before final acceptance.

G. Inspections

1. Pre-Installation Inspection: Inspection of all equipment and material to be used prior to installation. Compliance of all items shall be verified against the specifications and all other applicable standards. All equipment, cable, and associated hardware identified for installation shall be inspected for damage and completeness utilizing standard practices to determine integrity and acceptability.
2. In-Progress Inspection: At the Project Manager's discretion in-progress inspections shall be performed covering visual inspections of equipment, wiring practices, cabling, placement of equipment, marking of cables and adherence to safety procedures.
3. Final Inspection: The Contractor shall conduct a final inspection that encompasses all portions of the installation. This inspection shall be performed to ensure that all aspects of the installation have been performed in accordance with these Specifications, standard industry practices and the publications referenced herein. All non-compliance items shall be noted by the Contractor during this inspection.

4. Corrective Action and Verification Inspection: The Contractor shall perform corrective actions to ensure that all non-compliance items identified during the final inspection have been corrected.
5. Contractor shall ensure that all work performed under these Specifications (Sections) is in accordance with the requirements and standards defined and referenced therein. Any work performed in deviation of these Specifications (Sections), the referenced material, or any applicable standards or requirements, shall immediately be corrected by the Contractor without additional charges, regardless of the stage of work.

3.3 INSTALLATION

A. General: Install all work, meeting the requirements of the Contract Documents and in accordance with product manufacturer's instructions and recommendations, NFPA requirements, and requirements as specified herein and on Drawings. Meet requirements of final, reviewed submittals for the work.

B. Workmanship: Install all equipment, materials, specialties, etc., in accordance with the best engineering practice and standards for this type of work. Follow the recommendations and instructions of the product manufacturer, unless otherwise specified or shown in the Contract Documents.

C. Surface Finishes: Ensure all surfaces and edges of miscellaneous steel, etc., are smooth and free of marks, burrs, roughness, and other defects. Make finish welds match parent material. Where possible, grind welds smooth; remove flux, oxide, splatter or any other residue from the weld and adjacent areas of exterior and interior surfaces. Do not use synthetic type filler putty as metal filler.

D. Painting and Coatings:

1. Construct or finish all external components and PLB surfaces with inherently rust / defect / corrosion-resistant materials (i.e., stainless steel, glass, or plastic) or factory coat to ensure that the materials will be rust / defect / corrosion resistant to the tropical environmental conditions as specified.

E. Identification and Labeling:

1. Provide nameplate labels and signs as called for herein. Provide a nameplate for each PLB, each PLB control console panel, each electrical junction box, and each major equipment item (e.g., each motor).
2. Permanently attach each nameplate to each item and show at least the following in English:
   a. Equipment Number (to be provided by Project Manager /Employer)
   b. Manufacturer’s name and address.
   c. Date of manufacture.
   d. Manufacturer’s serial number.
   e. Motor rating (voltage and kW or HP) and Motor speed (rpm); for motors.
   f. Equipment ratings, where appropriate.
3. Furnish nameplates of engraved stainless steel, permanently attached with stainless steel screws.
4. Tag all electrical power and control cables which interface with terminal contractor- furnished cables to clearly identify the function and rating of each cable. Similarly, identify all terminations in junction boxes by tag, and cross-reference to

a tabulation to clearly identify each service contained.

F. Inspections and Tests:

1. General: Test all of the equipment installed under this Specification and demonstrate its proper operation to the Employer. Furnish all required labour, testing, instruments and devices required for tests and pay for all expenses involved in conducting such tests. Give 48 hours written notice to the Employer of all tests and demonstrations.

2. Inspection: Inspection includes but is not limited to:
   a. Rotation: Check drive shaft rotation direction and speed.
   b. Blocking: Remove blocks and other similar devices used to block shafts during shipment to the field or during alignment work.
   c. Alignment: Check whether equipment has been aligned.
   d. Lubrication: Check lubricant types and levels.
   e. Tightening: Tighten bolts, capscrews and other fasteners.

G. Install electrical connections for power, controls, and devices in accordance with the recommendations / requirements of the IEC and IET wiring regulations or equivalent international standards, subject to Project Manager's acceptance. Electrical power and control wiring and connections are specified in the Electrical Sections. Install and adjust motors in accordance with manufacturer's published instructions.

H. Perform the following equipment pre-operational checking activities, where appropriate or if not already performed and accepted at FAT. Coordinate these activities with the startup and testing work.

1. Lubricate oil lubricated type bearings, as appropriate. Fill with new lubricant according to manufacturer's recommendations.
2. Disconnect equipment drive couplings and check motors for proper rotation. Ensure rotation matches direction of rotation marked on equipment casing.
3. Check that all rotating equipment is free to rotate by hand.
4. Check that controls are correct for required application.
5. Check for fluids leakage from any mechanical or electrical devices

I. Field Testing and Final Checking: After the equipment has been installed and the various units have been inspected, adjusted, and placed in correct operating condition, field test the equipment in accordance with manufacturer's written testing procedures as accepted by the Project Manager. Demonstrate that the equipment functions in compliance with the specifications over the entire range of operation. Report any unusual conditions. Correct deficiencies of any of the field installed units.

J. Docking Tests: Conduct docking tests to demonstrate simulated docking. Use metal plate located by forklift at the aircraft door locations.

K. Install a new fire extinguisher, UL Listed, ABC Rated 3A:40B:C.

L. Hardware/Device/Component Installation

1. Provide an Installation Methodology Document,
2. Provide an Inspection and Test Plan (ITP),
3. Provide all required licenses.
4. All items, components, cables, etc. will be labelled as per the agreed labelling

scheme,

5. Allow for protecting, moving and stacking existing materials, equipment, etc.
6. Provide covering with tarpaulins, dust sheets or other materials as appropriate and remove them when no longer needed,
7. Properly ground each piece of electrical equipment prior to providing power in accordance with electrical guidelines and standards,
8. Perform all hardware tests at the equipment and subsystem levels to verify that the requirements of these equipment and subsystems have been met,
9. Include Power-On Self-Test reports (POST),
10. Perform the required System initialization and configuration and record the optimal settings for all devices and equipment to be included in the Operation and Maintenance Manual,
11. Perform tests and adjustments to assure satisfactory quality and performance of the system under operational conditions.

M. Racks Installations

1. All items, components, cables, etc. will be labelled as per the agreed labelling scheme
2. Contractor shall follow the rack installation guidelines to be coordinated with the "Structured Cabling Network" Contractor
3. Power cables, control cables, and high-level cables shall be run on left side of an equipment rack as viewed from the rear
4. Other cables shall be on the right side of an equipment rack, as viewed from the rear
5. Equipment mounted in drawers or on slides shall be provided with cables long enough to allow full extension of the drawer or slide. Include a service loop of at least 915 mm.

N. Network interfaces

1. For testing and commissioning of the overall network interfaces related to PLB CMS, to comply with Section 27 05 01 Common Clauses for IT and Security Systems

O. PLB CMS Test Environment

1. The Contractor shall define and deliver a "test platform".
2. The Contractor shall describe and deliver all simulators required for integration purposes.
3. The Contractor shall deliver all database scripts used to update the operational database from the test database and vice-versa.
4. The Contractor shall install any required automated test management tools from vendors who are acceptable to the Employer.
5. The Contractor shall describe the limitations of the test platform in order to allow the Employer's IT team to phase the testing:
    a. Tests that can be totally implemented on the "test platform".
    b. Tests that can be partially achieved on the test platform and that should be completely run on the "operational platform".

c. Tests that cannot be achieved on the “test platform” and that should be run on the “operational platform”.

6. Before the system becomes operational, all tests shall be performed on the “operational platform”.

7. Phased Testing:

   a. A phased acceptance test and performance demonstration program shall be developed and documented by the Contractor.
   b. This testing shall apply to all system components including, but not limited to, servers, gateways, bridges and cabling, the systems workstations including all PCs, monitors, keyboards, printers, and Network Interface Cards, and all software including configuration data.
   c. The Contractor shall provide a test plan for each phase with a description of exercise/test designs, operational scenarios used to simulate operational procedures, specific scripts and data sets.
   d. The Contractor shall provide the complete set of results at the end of each phase.
   e. The problems identified in each phase shall be corrected and demonstrated before any subsequent testing phase is performed.

8. Partial roll-out:

   a. If required, the Contractor shall carry out the tests sequentially according to the development planning: for instance, the core product may be tested and deployed before the complete version of the system is deployed.

   b. The Contractor shall incorporate this phasing in the overall project planning.

9. Initial Field Acceptance Tests (IFAT):

   a. This testing phase shall be required to verify that the systems are performing properly after installation.

   b. This phase shall consist of :
      I. On-site inspection.
      II. Testing of individual components and,
      III. Simulation of actual operations.

   c. The IFAT shall test all software, including, but not limited to, operating software, applications software, batch processing software, terminal emulators, as well as any database software of the systems. These tests shall be supervised by the Project Manager and Employer.

10. Systems Integration Tests (SIT):

    a. These tests shall include testing of the entire system, including all active components and connections to any external system. The test plan shall identify correct protocol communications and data message communications.

11. Final Acceptance Tests (FAT):

    a. Once the SIT phase is successfully completed, final acceptance testing shall be carried out to verify that each of the components is fully operational under actual conditions of operations.

    b. The FAT shall include, but not limited to, testing connections to physical

devices.

c. This phase shall include a system availability test.

d. Reports of all component tests shall be provided on a regular basis.

12. User Acceptance Tests (UAT):

a. Once the FAT is completed, the Contractor shall begin the handover to the assigned users of the system. The users may run the same tests as the FAT tests, but the focus shall be given to the coherency of the system, as far as work methods are concerned. The user-friendliness of the system shall also be thoroughly checked.

13. Initial Proving Period (IPP) (Experimental Period):

a. Once the UAT is completed, an Initial Proving Period of [three] months shall start in operational conditions: the software shall fulfill all requirements on a day-to-day basis.

b. If any major discrepancy is found in this IPP, the Contractor should be able to identify and fix it and to deliver a new version of the system. Each new delivery will reset the IPP for [three] more months.

c. Refer to Division 27 Section "Common Clauses for IT, Security & Special Airport Systems", Article "WARRANTY", Paragraph "Experimental Period".

14. Retesting: Correct deficiencies and retest until total system meets requirements of the Specifications and complies with applicable standards. Prepare written records of tests.

3.4 TAKING OVER CERTIFICATE

A. Prerequisites for the Taking Over Certificate (TOC)

1. Testing and commissioning has been successfully performed,

2. All closeout documents have been approved,

3. A Snag List with schedule for de-snagging has been agreed between the Contractor and the Project Manager,

B. Defect Liability Period (DLP)

1. DLP will commence from the time of TOC issuance and will run for a period of twenty-four

2. (24) months.

3. Correction of all defective materials (de-snagging) and workmanship in the installation will be carried out as scheduled within this period.

4. Operation, maintenance and expansion of the system by the operator shall not impact DLP.

5. During DLP any extensions of the system into other areas, or buildings outside the original scope of the Contract shall not relieve the Contractor of Contractual obligations.

C. Site Assistance and Adjustments

1. Appoint a manufacturer certified service representative as contact person for the DLP,
2. In case of system malfunctions, detected anomalies, unusual ageing of the components, performance degradation, workmanship issues, etc. the service representative will provide a rapid site intervention to ensure continuity of operation,
3. Provide on-site assistance and adjustments to the operator during DLP, provide for two site visits for this purpose at no additional cost,

3.5 MANUALS

A. Final manuals shall be provided by the Contractor upon completion

B. The Project Manager reserves the right to determine whether the above specified information as furnished by the Contractor is adequate and complete. The Project Manager may require additional submission by the Contractor to ensure that the documentation is complete and satisfactory

C. The O&M manuals shall contain adequate documentation of operating instructions for the System to be used by administrators, operators and technical personnel. The manual contains:

1. All settings, configuration scripts and configuration files
2. All command sets and the procedures/response in connection with each command
3. Operation, housekeeping and maintenance procedures
4. Initializing, reset, restart, reboot and other emergency procedures

3.6 ONSITE ASSISTANCE, TRAINING, AND MAINTENANCE

A. General: Provide onsite instructions / demonstrations to designated operating personnel covering operation, adjustments, and maintenance of PLB's.

B. Training: Provide on-site training of Employer's personnel in trouble shooting and problem solving. Include theory and hands-on training. On completion of training, issue each participant with a certificate of competency. Provide a minimum of 40 hours training for all the equipment, segregated into maintenance and operational trainings.

C. Maintenance: Beginning at initial acceptance, provide 400 days of full maintenance service by competent employees skilled in PLB operation. Use parts and supplies as used in the manufacturer of original equipment.

D. Warranty: The bridge Manufacturer shall provide an unconditional warranty for a minimum of 24 months (after successful finishing of the OMP) for the total of PLB installation. Full detail of the extended warrantied shall be provided for review and approval. In addition, a ten-year warranty is required for all exterior metal paint finishes.

Note :- PBB contractor to ensure that the final docking simulations reflect the final apron slopes as per the final grading scheme

PART 1 – GENERAL

1.1 Summary

This section outlines the requirements for IoT-based air quality sensors to be deployed across Jomo Kenyatta International Airport (JKIA) as part of the smart airport ecosystem. The sensors support monitoring of indoor environmental conditions and integration with smart airport applications and systems.

The system is designed to:

A. Enable real-time monitoring of air quality parameters
B. Support data-driven environmental control strategies

1.2 Scope of Work

The scope includes supply, installation, integration, testing, and commissioning of IoT air quality sensors, including:

A. Sensor devices and associated hardware
B. Integration with IoT platforms and building management systems
C. Testing, commissioning, and handover documentation

1.3 Standards & Compliance

All systems shall comply with relevant international standards for:

A. Indoor air quality and environmental monitoring
B. IoT communication protocols and interoperability
C. Cybersecurity and data protection

1.4 System Requirements

A. Sensors shall support continuous monitoring and data transmission
B. Systems shall allow for scalability and future expansion
C. Data shall be securely transmitted and accessible via centralized platforms
D. Integration with other airport systems (e.g., BMS, IoT platforms) shall be ensured

PART 2 – PRODUCTS

2.1 Air Quality Sensors

Sensors shall provide continuous monitoring of key environmental parameters, including:

A. CO_2
B. Particulate Matter (PM2.5 / PM10)
C. Total Volatile Organic Compounds (TVOC)
D. Temperature
E. Relative Humidity

Sensors shall:

A. Provide accurate, real-time measurements
B. Support remote calibration and monitoring
C. Be suitable for indoor airport environments

2.2 Connectivity & Integration

Sensors shall support:

A. Wireless communication (e.g., Wi-Fi or equivalent)
B. Optional wired connectivity (e.g., Ethernet / PoE)
C. Standard communication protocols (e.g., MQTT, HTTP/HTTPS)

All devices shall integrate with:

A. Building Management Systems (BMS)
B. Data analytics and monitoring systems

2.3 General Requirements

A. Equipment shall be robust, scalable, and suitable for continuous operation
B. Products shall be from approved manufacturers and meet performance requirements
C. Systems shall allow interoperability with other smart airport systems

PART 3 – EXECUTION

3.1 Installation

A. Sensors shall be installed in accordance with manufacturer recommendations
B. Locations shall be coordinated with architectural and MEP layouts
C. Installation shall ensure optimal coverage and performance

3.2 Testing & Commissioning

A. All sensors shall be tested prior to and after installation
B. System integration and communication shall be verified
C. Performance shall be validated against specified requirements

3.3 Operation & Maintenance

A. Systems shall include provisions for monitoring, maintenance, and updates
B. Training shall be provided to relevant operational staff
C. Documentation shall be provided, including manuals and system configurations

AQ SENSOR

PART 1 – GENERAL

1.1 Summary

This section outlines the requirements for IoT-based air quality sensors to be deployed across Jomo Kenyatta International Airport (JKIA) as part of the smart airport ecosystem. The sensors support monitoring of indoor environmental conditions and integration with smart airport applications and systems.

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A. Sensor devices and associated hardware
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All systems shall comply with relevant international standards for:

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C. Performance shall be validated against specified requirements

3.3 Operation & Maintenance

A. Systems shall include provisions for monitoring, maintenance, and updates
B. Training shall be provided to relevant operational staff
C. Documentation shall be provided, including manuals and system configurations

PART 1 – GENERAL

1.1 Summary

This section outlines the requirements for a Fault Detection and Diagnostics (FDD) module to be implemented as part of the Jomo Kenyatta International Airport (JKIA) smart airport ecosystem.
The FDD module enables continuous monitoring and analysis of building systems to identify faults, inefficiencies, and performance gaps, supporting data-driven operations and maintenance.

1.2 Scope of Work

The scope includes the provision and implementation of the FDD module, including:

A. Configuration of the FDD module within the overall digital ecosystem
B. Integration with BMS, IoT systems, and other data sources
C. Setup of analytics, dashboards, and reporting functions
D. Testing, commissioning, and handover

1.3 System Requirements

A. Continuous analysis of system performance using operational data
B. Integration within the overall smart airport ecosystem
C. Secure data exchange and interoperability with connected systems
D. Scalable configuration to support future expansion

PART 2 – PRODUCTS

2.1 FDD Module

The FDD module shall include:

A. A data analytics engine processing time-series data from connected systems
B. A user interface with dashboards and visualization tools
C. Deployment within the airport's digital infrastructure (cloud or on-premise)

2.2 Data Integration

The module shall integrate with:

A. Building Management Systems (BMS)
B. IoT sensors and devices
C. Metering System
D. Other airport operational and digital systems

Integration shall be achieved through standard protocols and open APIs, ensuring reliable and secure data exchange.

2.3 Analytics & Functionality

The FDD module shall provide:

A. Rule-based and AI-driven fault detection
B. Identification of anomalies, inefficiencies, and system faults
C. Monitoring of energy, environmental, and operational performance
D. Prioritization of issues with actionable insights for operations teams

PART 3 – EXECUTION

3.1 Installation & Integration

A. Configuration and integration of the FDD module within the existing systems
B. Coordination with all relevant stakeholders and system providers
C. Alignment with the overall smart airport architecture

3.2 Testing & Commissioning

A. Verification of system integration and data flow
B. Validation of analytics and fault detection outputs
C. Completion of system testing and acceptance

3.3 Operation & Training

A. Training for operational and maintenance teams
B. Provision of user documentation and system guidelines
C. Support for ongoing operation and optimization

FDD

PART 1 – GENERAL

1.1 Summary

This section outlines the requirements for a Fault Detection and Diagnostics (FDD) module to be implemented as part of the Jomo Kenyatta International Airport (JKIA) smart airport ecosystem.
The FDD module enables continuous monitoring and analysis of building systems to identify faults, inefficiencies, and performance gaps, supporting data-driven operations and maintenance.

1.2 Scope of Work

The scope includes the provision and implementation of the FDD module, including:

A. Configuration of the FDD module within the overall digital ecosystem
B. Integration with BMS, IoT systems, and other data sources
C. Setup of analytics, dashboards, and reporting functions
D. Testing, commissioning, and handover

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