REPUBLIC OF KENYA

MINISTRY OF TRANSPORT

DEPARTMENT OF AIR ACCIDENT INVESTIGATION

ACCIDENT REPORT 5Y-LMB

P.O. Box 52692- 00200 Nairobi

Telephone: 254-20-2729200 Fax: 254-20-2737320

CIVIL AIRCRAFT ACCIDENT REPORT

CAV/ACC/LMB/09

OPERATOR:	AFRICA INLAND MISSION
OWNER:	AFRICA INLAND MISSION
MANUFACTURER	CESSNA AIRCRAFT COMPANY
AIRCRAFT:	CESSNA U206G
NATIONALITY	KENYAN
REGISTRATION:	5Y-LMB
PLACE:	WILSON AIRPORT
	Co-ordinates 01°19′18″S 36°48′54″E
DATE:	01 AUGUST 2009
TIME:	1122

All times given in this report is Coordinated Universal Time (UTC)

East African Local Time is UTC plus 3 hours.

TABLE OF CONTENTS

TABLE OF ABBREVIATIONS 9

SYNOPSIS 11

1. FACTUAL INFORMATION 13

1.1. History of Flight 13

1.2. Injuries to persons 13

1.3. Damage to Aircraft 13

1.4. Other damage 14

1.5. Personnel Information 14

1.5.1. The Captain 14

1.6. Aircraft Information 15

1.6.1. General 15

1.6.2. Fuel system of Cessna 206 16

1.6.3. Mass and Balance 17

1.7. Meteorological Information 17

1.8. Aids to navigation 17

1.9. Communications 17

1.10. Aerodrome Information 17

1.11. Flight Recorders 18

1.12. Wreckage and impact information 20

1.13. Medical and pathological information 20

1.14. Fire 20

1.15. Survival Aspects 20

1.16. Tests and Research 20

1.17. Organization and management information 24

1.18. Additional information 25

2. ANALYSIS 25
3. CONCLUSIONS 26
3.1. Findings 26
3.2. Probable Cause 27
4. SAFETY RECOMMENDATIONS 27

TABLE OF ABBREVIATIONS

AMP-Amperes

AVGAS-Aviation Gasoline

KCAA-Kenya Civil Aviation Authority

CPL-Commercial Pilot License

HKNW-Wilson Airport

COA-Certificate of Airworthiness

COR-Certificate of Registration

ICAO-International Civil Aviation Organization

EDM-Engine Data Monitor

OT-Oil Temperature

OP-Oil Pressure

VDC-Voltage Direct Current

MPG-Miles per Gallon

FP-Fuel Pressure

EGT-Exhaust Gas Temperature

CHT-Cylinder Head Temperature

RPM-Revolutions per Minute

MP-Manifold Pressure

HP-Horse Power

OAT-Outside Air Temperature

GPH-Gallons per Hour

AIM-Africa Inland Mission

POH-Pilot Operating Handbook

SYNOPSIS

The Air Accident Department was informed about the accident shortly after occurrence and prompt investigations were instituted accordingly. The aircraft, a Cessna 206 registration 5Y-LMB was reported to have hit an electric pole, before it went tumbling down and crashed onto a residential flat in Highrise Estate, killing a pilot, seriously injuring an engineer and the two photographers on board escaped with minor injuries. The engineer was later airlifted to Republic of South Africa for further treatment, where he, succumbed to the injuries he had sustained during the crash.

Shortly after impact with both the building and the ground, the aircraft was engulfed in fire, which was put off by the members of the public assisted by Wilson Airport fire attendant during the rescue exercise.

.

Picture: Cessna U206G aircraft, similar to 5Y-LMB that crashed in a residential area.

1. FACTUAL INFORMATION

1.1. History of Flight

The Cessna 206 aircraft registration 5Y-LMB departed Wilson Airport for a commercial aerial photography of the vast Kibera Slums in Nairobi at 1109 on 1 August 2009 with four occupants. A pilot, an Engineer seated next to him as a passenger and two camera men, one in the middle and the other in the aft rows respectively.

The aircraft took off from Runway 14 after picking up the two filming crews from customs/security area of Wilson Airport and made a right climbing turn, overflew the threshold of runway 07 and set course for the Kibera slums.

After the filming exercise, the aircraft intended to go back and land at Wilson airport.

1.2. Injuries to persons

Injuries	**Crew**	**Passengers**	**Others**
Fatal	1	1	-
Serious	-	-	-
Minor/None	-	2	

1.3. Damage to Aircraft

The aircraft was destroyed by both the impact and the post crash fire. The propellers dislodged from the engine that lay inverted separately from the fuselage.

1.4. Other damage

The intense heat from the ensuing inferno caused the window panes on the crash building to shatter and section of the building wall was smouldered.

1.5. Personnel Information

1.5.1. The Captain

The pilot, an American male aged 35, held valid Kenyan Commercial Pilot License (CPL) No. YK-5889-CL and Flight Radio Telephony Operator`s License No YK-5889-RL issued by the KCAA. The CPL had coverage for fixed wing aero planes and was to lapse on 4 July 2010. Pilots logs obtained from the company indicated that the captain had flown a total of 1973.2 flight hours, 294.1 hours on Cessna 206 type of aircraft of which 28.3 hours for three months prior to the accident. The records show that the pilot underwent both VFR and Air route proficiency checks on 12 January 2009 and 13 April 2009 respectively. The records indicate no previous incident or accident by the pilot; furthermore, there were no known complaints about him from other pilots or workmates.

1.6. Aircraft Information

1.6.1. General

Manufacturer	Cessna Aircraft Corporation
Type	Cessna U206G
Aircraft Serial Number	U20604205
Year of manufacture	1978
Number and type of engines	One IO-520F
Shaft Horsepower (Takeoff; Max Continuous.)	300; 285
Total Airframe hours	5738.1
Certificate of Registration	Kenyan registered
Certificate of Airworthiness	Commercial Air Transport (Passengers). Valid until 09 October 2009.

The aircraft was previously registered in the United States of America under the registration N756MS before being entered into Kenyan civil aircraft register as 5Y-LMB, with a certificate of airworthiness under Commercial Air Transport category.

1.6.2. Fuel system of Cessna 206

The two fuel system consists of two vented integral fuel tanks, one in each wing, two fuel reservoir tanks, a fuel selector valve, auxiliary fuel pump, fuel strainer, engine driven pump, fuel/air control unit, fuel manifold, and fuel injection nozzles.

Unusual fuel is at a minimum due to the design of the fuel system. However, when the fuel tanks are ¼ full or less, the prolonged uncoordinated flight such as slips or skids can uncover the fuel tank outlets, causing fuel starvation and engine stoppage.

Fuel flows by gravity from the two integral tanks to two reservoir tanks, and from the reservoir to a three-position selector valve labeled LEFT ON, RIGHT ON AND OFF. with the selector valve in the LEFT ON or RIGHT ON position, fuel from either the left or right tank flows through a bypass in the auxiliary fuel pump(when it is not in operation),and through a strainer to an engine driven pump. The engine- driven fuel pump delivers the fuel to the fuel/air control unit where it is metered and directed to a manifold which distributes it to each cylinder.

NOTE

Fuel cannot be used from both fuel tanks simultaneously.

Vapor and excess fuel from the engine driven fuel pump and fuel/air control unit are returned by way of selector valve to the reservoir tank of the wing fuel tank system being used.

Fuel system venting is essential to system operation. Complete blockage of the venting system will result in decreasing fuel flow and eventual engine stoppage. Venting is accomplished by vent lines, one from each fuel tank, which are equipped with check valves. The fuel filler caps are equipped with vacuum operated vents which open, allowing air into the tanks, should the fuel tank vent lines become blocked.

1.6.3. Mass and Balance

No weight and balance sheet pertinent to the flight was provided.

1.7. Meteorological Information

The following weather phenomena prevailed at the time of the accident as issued by the Dagoretti Weather Station.

Wind was Southerly with an average speed of five knots with visibility better than ten kilometers. Outside air temperature and Dew point temperatures were twenty and twelve degrees Celsius respectively. Cloud cover was broken with a base of two thousand feet above ground level.

Sunlight conditions prevailed at the time of the accident.

1.8. Aids to navigation

The flight was being conducted under visual flight rules, and the notable visual ground aids in use at the time were, Wilson airport, Monastery, Kibera slums and the buildings within Nairobi town vicinity.

There were broken clouds with a base of 2000 feet above ground level, and since it was a low level flight and the visibility was better than 10km, then, the visual navigation aids were in use and quite effective at the time of the crash.

1.9. Communications

The pilot was in a two way communication with Wilson tower, and no distress message was received from him.

1.10. Aerodrome Information

HKNW is located five kilometers south of Nairobi and serves both domestic and international air traffic. It is located at latitude 01° 19' 18.19" S and longitude 036° 48' 53.40" E at an elevation of 5370 feet. The aerodrome operating hours

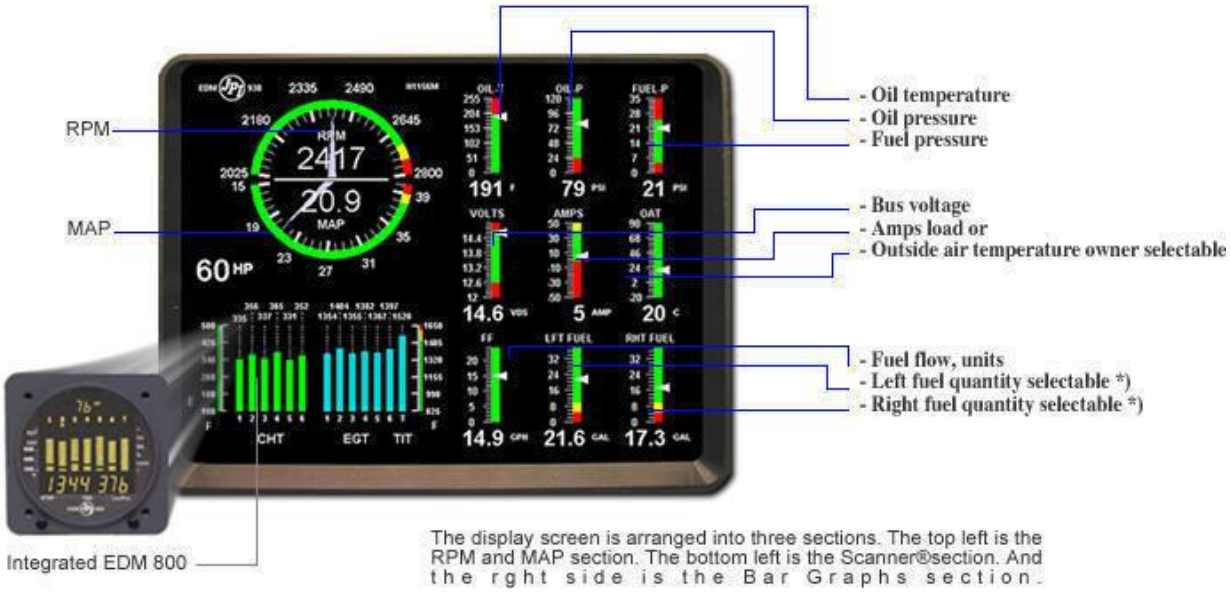
are from 0330 to 1730. The airport has four asphalt runways 07/25 (1463×24M), 14/32 (1560×23M) with PCN 015BXU for all runways.

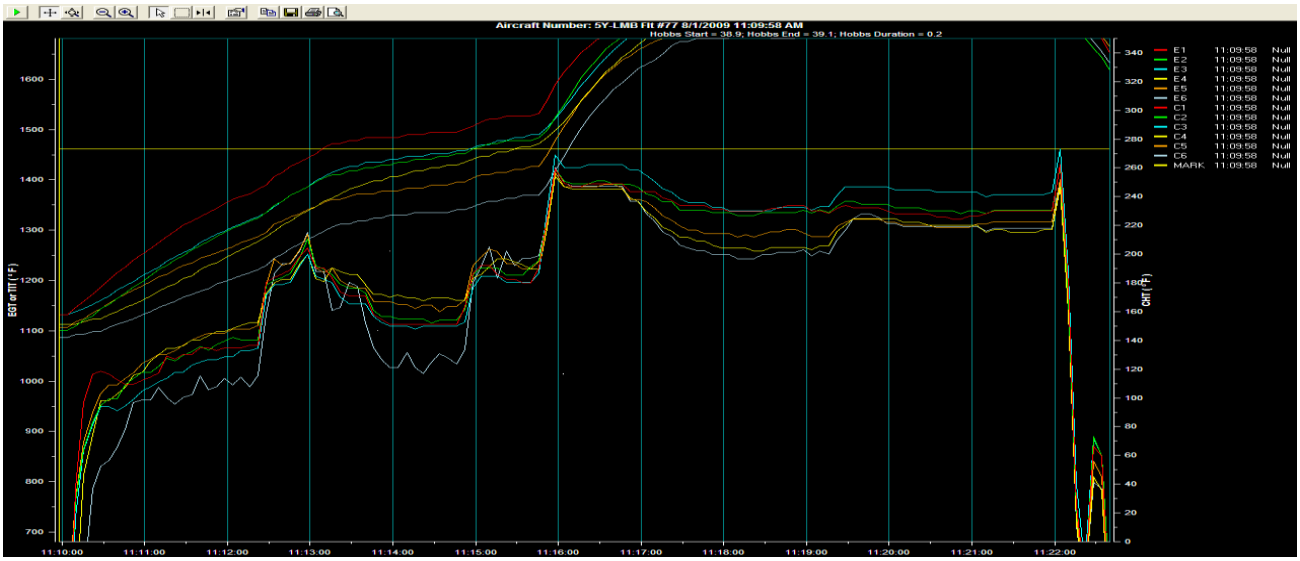
The airport is not equipped with any approach landing facility or equipment, however, it is served by medium light intensity.

1.11. Flight Recorders

The aircraft was not fitted with flight recorders, but was equipped with piston Engine Data Monitor 930 instrument that does trend monitoring and records the engine parameters every six seconds.

The EDM and the fuel scan installed specialises and analyses parameters such as, EGT,CHT,RPM,MP,HP,OT,OAT,VDC,GPH,MPG,FP and AMP.





One of the parameters indicated and recorded by the EDM is the fuel flow and fuel level in each tank in relation to the bank angle of the air craft.

When the air craft banks to the left side, the fuel flow to the engine from the left fuel tank increases, and vice versa.

1.12. Wreckage and impact information

The aircraft collided with the post and the building before hitting the ground, the propeller detached from the engine, and tail unit separated from the fuselage.

1.13. Medical and pathological information

No evidence indicated any medical conditions that might have adversely affected the pilot`s performance during the accident flight as per the post mortem report

1.14. Fire

There was post crash fire that ensued due to the available AVGAS in the aircraft fuel tanks.

1.15. Survival Aspects

The crash impact was survivable, chances of rescuing the middle and rear row passengers were boosted by the easy access to them because the rear door had been removed for photography purpose. However, for the front occupants survival aspects were less because of the severity of the impact.

1.16. Tests and Research

5Y-LMB Engine Investigation

10 & 11 August 2009

After the inspection of the engine by the persons below, the following were found:

Persons present at Propulsion Systems for investigation:

- Mr. Peter Wakahia – Accident Investigator, Ministry of Transport
- Mr. Ken Taylor – Shop Manager, CMC Aviation (certifier of engine overhaul)
- Mr. James P. Levander – Chief Inspector, AIM AIR
- Mr. Stephen Kituo – Engine Shop Supervisor, AIM AIR
- Mr. Jon Egeler – President & CEO, Mission Safety International
- Mr. Steven Morrell – Accident Investigator, Mission Safety International
- Mr. & Mrs. Chris Daniker – Insurance Adjusters, AIRMAP

The following items were removed before arrival of the investigation team noted above:

- Engine baffling
- Engine mounts
- Top spark plugs
- Cylinder rocker covers
- Starter
- Exhaust collectors

The fuel line from the fuel controller to the fuel manifold was disconnected at the fuel flow transducer to facilitate the baffling removal. No fuel or oil lines were checked for torque before the work was initiated, but there was no evidence to suggest any significant leakage.

Notes on external inspection:

- Front, right crankcase had a piece missing all the way to the crankshaft bore.
- Crankshaft sheared near prop flange.
- Oil cooler and adapter plate (normally mounted at front, right of engine case) was missing from engine, oil temperature probe still in place.

- Cylinder #5 (left, front) was badly damaged from the engine being dropped.
- RH magneto had broken off mounting pad.
- Fuel pump was broken at low pressure adjustment and high pressure orifice.
- Alternator drive pulley on starter adapter had broken off the shaft with the key no longer in place.
- Alternator driven pulley/fan cage bent, but alternator spun freely. Belt was torn completely in one place, but still in one piece.
- All lines still with the engine seemed to be secure at the existing ends.
- All engine controls were severed but still attached. Unable to determine accurately what position they were in at the time of accident. Throttle arm was badly bent.
- Exhaust and induction badly damaged.
- Top cylinder spark plugs looked normal.
- Propeller spinner badly damaged. Crank flange still attached at hub, three nuts still holding, other three studs sheared. One blade bent forward, the other two bent backwards.

Teardown and inspection sequence of Monday, 10th of August:

- Removed oil sump, and found a few stones and some dirt; probably came through the hole in the front.
- Removed alternator and alternator integral mount leg.
- Installed four serviceable mount legs.
- Turned crankshaft at starter pad with large screwdriver. Crankshaft turned freely for less than a full stroke. Movement was not sufficient to note valve movement.
- Turned crankshaft with pipe wrench at crankshaft flange area. Made some turning but would not move any longer.
- Mounted engine on engine stand.

- Removed damaged cylinder #5 (left, front).
- Engine was able to spin freely and confirmed movement of valves and firing of magneto impulse couplings.
- Rotated engine inverted and noted no internal discrepancies. The oil had 41.2 hours on it since the last oil change and was very clean. The internal parts were clean. The camshaft lobes were not worn outside of normal parameters. No signs of gear teeth wear.
- Removed and cut open oil filter. Checked each pleat for ferrous metal contaminants using magnet and flashlight. Found none. Poured oil from filter can through a dust mask. Found no contaminants.
- Removed fuel controller inlet fuel screen. Found 25% - 30% coverage of screen. The majority of the contaminants seemed to be fabric or fibrous in nature – possibly from rags or other cloths. Pictures were taken and the screen was put in a clean bag.
- Removed fuel manifold cover and checked screen – found minimal contaminants, more lint or fibrous material. Re-installed cover.

Decision was made to continue the inspection on the following day at 10:30 a.m. Workers were told to have the fuel system and magnetos set-up for testing by that time.

Testing and inspection sequence of Tuesday, the 11th of August:

- RH magneto was tested with a serviceable harness attached. Magneto ran successfully at a variety of RPMs. Ground check (magneto cut-out check) was made and was satisfactory.
- LH magneto was tested in the same manner with the same results.
- Bottom spark plugs were removed and it was decided that all plugs would be tested at AIM AIR.
- The head from the broken cylinder #5 was manipulated to allow removal of the top spark plug and the fuel injector nozzle. The fuel injector nozzle was then installed on the removed fuel system for testing.
- The fuel flow transducer had been removed from the system but not added to the test set-up. The transducer was tested alone by blowing

through the inlet port – no restriction was noted. It was then added to the fuel system set-up for testing with the whole system.

- The fuel system was set-up as in the aircraft, but the fuel pump was too badly damaged to be used for testing. A serviceable pump was used with the engine's fuel controller, the JPI fuel flow transducer, the engine's fuel manifold, the original fuel lines and the original fuel injector nozzles, which are a GAMIjector modification. The GAMIjectors were installed in the correct lines as per tags on the lines and markings on the injectors. After some set-up difficulties, the fuel system was run successfully and the fuel out of each injector caught in equally-sized containers. Containers from each injector were matched with the opposing cylinder's injector and found to be equal in fuel output and therefore operating correctly. Nozzles were checked for contaminants and obstructions – found none.

- The engine-driven fuel pump was disassembled. The seat of the fuel bypass ball bearing was found to be worn approximately 1/3 of its circumference. The wear was not determined to be excessive. The low pressure adjustment valve was worn in the seated area, but again, it was not excessive wear. All other items looked normal and the pump drive moved freely when assembled.

- Induction air box was inspected for obstructions – found none. Alternate air door could not be operated, but was in the normally closed position. Engine air filter was in normal condition, and screen was secure in the filter housing.

- All spark plugs were tested later that evening at AIM AIR and none failed the testing except the badly damaged top one from cylinder #5.

- Broken pieces of engine mount legs were also taken to AIM AIR for matching up with their other halves on the airframe.

1.17. Organization and management information

Africa Inland Mission (AIM) is a Christian organization that holds a current Air Operators Certificate KCAA/FOPS/3010/6 and Air Service Licence KCAA/LAS/0596 for public transport and operates a mixed fleet of aircraft

comprising of CESSNA 206, 210, BE20 and DC 3TP types. The Organization has its own Aircraft Maintenance Organization REF IL/MO/L/006.

1.18. Additional information

It was not possible to ascertain the exact altitude of the aircraft when the engine ceased prior to the crash.

2. ANALYSIS

At the time of take off, the aircraft airlifted 30.7gallons of fuel on board, 11gallons in the Right tank and 19.7 in the left. According to the POH, each tank was capable of carrying a maximum of 42gallons of fuel.

The data collected from the JPI Engine Data Monitor EDM 930 indicated fuel starvation to the engine resulting to loss of engine power and subsequent engine cessation.

According to the Africa Inland Mission flight following form dated 31st July 2009, the Cessna 206 5Y-LMB was last filled up with fuel in Lodwar on the same day (five hours flight time).

5Y-LMB then took off at 1232 from Lodwar and flew to Wilson airport, Nairobi, where it landed at 1500, flight time of 2hours and 28minutes.

The following day, 1st August 2009, which was the fateful day of the crash, fuel was neither added nor removed from the aircraft. This implies the endurance at the time of start up was about 2hours and 30minutes.This is equivalent to 32 gallons and is in conformity with the initial total fuel in the aircraft prior to the flight as indicated by the Engine Data Monitor (EDM)

This therefore, rules out the possibility of engine fuel starvation as a result of lack of sufficient fuel in the tank for the flight.

The Cessna 206 was fitted with header tanks situated below three position fuel selector valve, labelled LEFT ON, OFF and RIGHT ON.

With the selector on OFF position, the fuel within the system cannot sustain the engine running for a minute. This aspect overrules the possibility that the

aircraft might have taken off with the fuel selector in OFF position that might have caused engine fuel starvation.

It is unlikely that the Cessna 206,5Y-LMB had fuel starvation due to inadvertently mismanagement of the fuel mixture control lever, either by the pilot or the first passenger.

The most probable cause of the engine fuel starvation is therefore, flying with the fuel selector valve on RIGHT ON, and making the prolonged uncoordinated right turns from takeoff runway 14 to the time of crash. The right tank had 11 Gallons of AVGAS, which is less than a quarter of the tank, and the aircraft was flying uncoordinated manoeuvres to enable the camera crew to take vantage pictures and in the process there was no sufficient fuel flow to the engine leading to loss of power due to engine cessation caused by fuel starvation. The EDM indicated a slight resumption of fuel flow to the engine towards the end, and subsequent slight engine resumption.

This could have been caused by the plane being flown straight and level momentarily, leading to resumption of the fuel flow to the engine, but since the height above ground level being flown was not enough for full engine recovery, the Cessna 206 crashed in to a building.

3. CONCLUSIONS

3.1. Findings

- There was post fire crash
- The flight was authorized.
- The Cessna U206G had 30gallons of fuel at start up for the maiden flight.
- There was fuel starvation to the engine as recorded by EDM.
- The pilot was certificated and qualified under the existing civil regulations and company training requirements.
- The Cessna U206G was certificated and was equipped and maintained in accordance with the existing KCAA regulations.

- The investigation revealed no infringement of the current KCAA regulations by the operator.

3.2. Probable Cause

The probable cause of the accident was fuel starvation. This could have been as a result of uncoordinated flight with fuel quantity at ¼ full or less which could have uncovered the fuel tank outlets causing fuel starvation and engine stoppage. The fuel capacity of each tank is (standard) is 42Gal.On commencing the flight the aircraft had a total of 30.7 Gal.11 .0 on the right and 19.7 on the left tank.

4. SAFETY RECOMMENDATIONS

1. KCAA should set out requirements for approving special flights-training based on the circumstances of the flight and the type of aircraft used.
2. KCAA should have a requirement that an operator conducts a flight risk assessment before approval.