

CAV/ACC/4/73

EAST AFRICAN COMMUNITY

ACCIDENT INVESTIGATION BRANCH,

P.O. BOX 30163,

NAIROBI

May, 1973


The Chairman,
Communications Council,
ARUSHA.

Sir,

I have the honour to submit a report by Mr. P. J. Adams, Inspector of Accidents, into the circumstances of the accident to Cessna TU 206D, Aircraft Registration Number 5H-MOH, which occurred on the 13th April, 1973 at Dosi-Dosi, Tanzania.

I am, Sir,

Your obedient servant,


(D. C. Stewart)

CHIEF INSPECTOR OF ACCIDENTS.

DCS/ZH

CAV/ACC/4/73

ACCIDENT INVESTIGATION BRANCH

CIVIL AIRCRAFT ACCIDENT

REPORT ON THE ACCIDENT TO CESSNA TU 206D

AIRCRAFT REGISTRATION NUMBER 5H-MOH

WHICH OCCURRED ON THE 13TH APRIL

1973 AT DOSI-DOSI, TANZANIA.

E A S T A F R I C A N C O M M U N I T Y

ACCIDENT REPORT

ACCIDENT INVESTIGATION BRANCH

CIVIL AIRCRAFT ACCIDENT REPORT NO. CAV/ACC/4/73

AIRCRAFT: Cessna TU 206 5H-MOH
ENGINE: Continental TS10 - 520 C
REGISTERED African Medical and Research Foundation
OWNER/OPERATOR: P.O. Box 30125, Nairobi.
PILOT: Mr. M.E. Barton - Killed
PASSENGERS: Nil
PLACE OF ACCIDENT: Approximately 18 N. Miles East/North/East
of Dosi-Dosi, Tanzania.
DATE & TIME: 13th April, 1973 at approximately 0745 GMT.

ALL TIMES IN THIS REPORT ARE G.M.T.

S U M M A R Y

On a flight from Dosi-Dosi in Tanzania to look at a new airstrip in the Handani Area, the aircraft crashed in bush country some 18 nautical miles East-North-East of Dosi-Dosi. When the accident site was visited, certain evidence came to light indicating the possibility of fire prior to crash impact.

The aircraft was destroyed by impact and fire and the pilot, the only occupant was killed.

The report concludes that there is sufficient evidence to presume pre-impact fire and draws attention to the combined hazards of combustible material and the toxic effect of fire extinguishers in confined areas.

1. INVESTIGATION

1.1 History of the Flight

On the morning of the 13th April the pilot flight planned Dodoma/Dosi-Dosi/Mvumi/Moshi.

Departure from Dodoma was 0630 hours and arrival at Dosi-Dosi 0700 hours.

Whilst at Dosi-Dosi, the pilot advised a Government Medical Assistant that he intended going to a new airstrip in the Handani area.

No reason can be given as to why the pilot should have decided to change his flight plan, other than to speculate that, as a conscientious Flying Doctor pilot there are obvious advantages of acquainting oneself with new airstrips in an area where mercy flights might be called for.

The change of plan would explain why the aircraft crashed in a position which would have been off-track from the course Dosi-Dosi to Mvumi.

Masai tribesmen said that they saw the aircraft crash and were insistent that they saw smoke and flame coming from the aeroplane before it hit the ground some 18 nautical miles East-North-East of Dosi-Dosi.

1.2 Injuries to Persons

Injuries	Crew	Passengers	Others
Fatal	1	-	-
Non-Fatal	-	-	-
Non-Fatal	-	-	-
None	-	-	-

1.3 Damage to Aircraft

The aircraft was totally destroyed by impact and fire.

1.4 Other Damage

None.

1.5 Crew Information

The pilot, Mr. Miles Edmund Barton, aged 22 years was the holder of East African Commercial Pilot's Licence No. 1324 (K.1203) issued on 2nd June, 1972, on the strength of an F.A.A. (U.S.A.) Commercial Pilot's Licence No. 2154778. This licence was renewed in November 1972, and valid until the 22nd May 1973.

Mr. Barton also held Flight Radio Telephony Operators Licence No. 2114 (K. 1558) issued on the 4th August 1970, and kept current in line with the C.P.L. described above. An instrument rating was also current at the time of the accident.

Mr. Barton's C.P.L. was rated for Cessna 170, 175, 180, 182 and 206 aircraft.

In an application dated 12th March 1973, Mr. Barton claimed a total of 672.00 hours as pilot in command and 70.00 hours as dual/P3 time. All this experience was on single engined aeroplanes with a large proportion on the Cessna TU 206.

1.6 Aircraft Information

The aircraft, a Cessna TU 206 constructor's serial number U206-1433 was constructed by the Cessna Aircraft Corp., Wichita, Kansas, United States of America, in 1969.

The aircraft arrived in East Africa with an F.A.A Certificate of Airworthiness for Export No. E.93671 in January 1970. Following an acceptance check the aircraft was issued with an East African Certificate of Airworthiness in the Public Transport Passengers Category on the 4th February, 1970. Subsequent renewals were made in 1971 and 1972. The last C. of A. renewal was carried out on the 5th March, 1973, valid until the 4th March, 1974.

Up until July 1972 the aircraft had been maintained to a Maintenance Schedule approved for commercial passenger operation. However, as the aircraft was not operated for hire or reward, but used privately for Flying Doctor operations, permission was granted for the aircraft to be withdrawn from the Commercial Maintenance Schedule and transferred to a Maintenance Schedule approved in the name of African Medical and Research Foundation. Maintenance inspections had been carried out and correctly certified to the requirements of this schedule. The last Certificate of Maintenance was issued on the 11th April 1973, valid for 75 flying hours or 60 days calendar period. Neither the flying hours limitation nor the calendar limitation had been exceeded at the time of the accident.

At the time of the accident the aircraft state was as follows:

Total time since Manufacture	1784.50
Time since C. of A. renewal	76.00
Time since C. of M. issue	5.30
Engine serial no. & Type - Continental	
TSIO -520-C Serial No. 140391-6-C	
Total Hours since new	1865.45
Hours since overhaul	552.55
Propeller Serial No. & Type -	
McCauley D3 A32C-90-K	
Ser. No. 687213	
Total hours since new	836.20
Hours since overhaul	592.50
Hours since last 3 year inspection on	
13th March 1973	69.15

1.7 Meteorological Information

No accurate meteorological information is available from official sources but witnesses in the area state that conditions were fine with good visibility and no rain at the time of the accident.

1.8 Aids to Navigation

Not applicable to this report.

1.9 Communications

The aircraft was fitted with VHF and HF transceivers both capable of operating Eastair Centre F.I.C. frequencies. The nearest VHF area cover relay station to the accident site is Bondwa on the Uluguru Mountains at approximately 100 N. Miles distance. Although at extreme range transmission might possibly have been received from the aircraft on 118.9 MHz. However no transmissions were recorded over the period. HF communication on 8959 or 8840 MHz with Eastair Centre should have been possible but no calls were heard.

On the flight from Dodoma to Dosi-Dosi (approximately thirty minutes duration) the aircraft did not contact Eastair Centre on either VHF or HF.

The aircraft radio station was inspected for Certificate of Airworthiness Renewal and approved on the 28th March 1973. Since that date there have been no reported deficiencies in the radio equipment.

1.10 The Airfield

The airstrip at Dosi-Dosi from which the aircraft departed is a murrum gravel strip partly grassed over, of approximately 600 metres by 15 metres width and aligned East/West. There is a pronounced slope upwards from West to East. The surface of the strip is very rough and would be expected to cause landing and take-off vibrations of a fairly severe nature.

1.11 Flight Recorder

No flight recorder was fitted or required by Regulations to be fitted.

1.12 The Wreckage

1.12.1 Impact

Study of the damage to trees in the impact area indicated that the aircraft struck the ground at an angle of approximately 70° and in a slight right banked condition.

1.12.2 Distribution

The main body of the wreckage was contained within an area of 36 feet (spanwise) by 20 feet (lengthwise). Only minor items such as wing-tip fragments were outside this area. The complete cabin area from cabin station '0' (firewall bulkhead) to cabin station 138 (rear cabin wall) had been compacted and completely burnt out.

1.12.3 Flying Controls

Due to burning it was impossible to ascertain without doubt that there had been no control failure. Sections of the Flying Control cables to the rudder and elevator control surfaces were however intact as far forward as the centre cabin area where burn damage was greatest. The control cables to the aileron surfaces were also intact, although burned, as far inboard as the centre cabin area. The flaps would appear to have been in the fully up position, although due to wing

distortion by fire and impact and the complete disintegration of the flap motor this cannot be stated as a certainty.

1.12.4 Propeller

The damage sustained by the propeller was severe due to impact. One blade was completely detached from the dome assembly and was found beneath the engine. The blade root bearing housings had failed on the other two blades. Impact damage was more severe on one half of the propeller spinner and backplate than on the other. There was almost no forward bending of the two propeller blades which were not buried in the ground, indicating that at the time of impact the engine was either stopped or was turning very slowly.

1.12.5 Engine

The impact had been violent enough to tear the magnetos from the front face of the rear cover flange and to eject the left-hand magneto drive from the casing. The fuel manifold (flow divider) was intact apart from a fracture of the union for the attachment of the fuel delivery pipe to the rear left hand (No. 2) cylinder injector nozzle. This delivery pipe had sprung rearward by approximately one inch. The fuel manifold (flow divider) and a section of the delivery pipe to the No. 2 Cylinder were removed for further investigation. Burning and blackening of the engine cowling was more severe on the internal surface than on the outer surface.

1.12.6 Instrumentation

Due to the severity of the fire and impact damage no useful information could be obtained from any instrument.

1.12.7 General

The fire extinguisher normally carried in the aircraft could not be found, although the fire extinguisher retaining bracket was in the centre of the wreckage. The ignition keys for the aircraft were also found in the wreckage loose from the ignition switch. The position of the fuel selector could not be determined.

1.13 Fire

Original reports from Masai tribesmen indicated that the aircraft was on fire prior to the impact. These reports were originally regarded as suspect, as this is not an uncommon statement where fire has subsequently broken out following impact, but in the light of investigation of the wreckage it would seem that this observation could well be justified.

1.14 Survival Aspects

The angle of descent and the violence of the impact together with the explosion of the fuel cells made the crash non-survivable.

1.15 Tests & Research

1.15.1 Fuel System

The fuel manifold - (flow divider) and the section of the fuel delivery pipe to the No. 2 injector nozzle were examined by binocular microscope. The union, by which the delivery pipe was attached to the manifold revealed a previous fracture extending some 280 degrees around the circumference of the adaptor body. A new break mark of some 80° around the circumference showed the last point of fracture. Oxydisation clearly showed on the ~~initial fracture~~, whilst the final break mark was bright with little or no oxydisation. Such a fracture could be caused by overtightening of the delivery pipe to the adaptor of the fuel manifold. Such overtightening would not necessarily be apparent to the engineer carrying out the task, although it could later reveal itself due to fuel staining and engine starting difficulties. Examination of the defect rectification worksheets for the aircraft for the month preceeding the accident, revealed three defects having an association with incorrect fuel operation. These were:-

- (a) 9th March 1973 'Fuel flow needs adjusting'.
- (b) 2nd April 1973 'Fuel flow (start) incorrect - cuts out H or C.
- (c) 11th April 1973 'Check idle cut-off'.

Each of the above defects had been cleared by rectification action, and had been properly certified by an engineer entitled to make such certifications. It is not intended to suggest that any or all of the defects above, had any direct bearing on the cause of the accident, and it must be accepted that the clearance of these defects was made following rectification of some abnormality and the system had been proved by test. By the same token, it must be accepted that an adjustment to one part of a (fuel) system can sometimes give the indication of satisfactory remedial action to a deficiency existing in other parts of that system.

1.15.2 Fire Extinguisher

Although no trace of the fire extinguisher usually carried in the aircraft could be found, tests were carried out to determine the effects of the discharge of an identical extinguisher in a Cessna 206 cabin.

The extinguisher used was a Pyrene B.C.F. 3 lb (26 fl. oz.) model P.A. extinguisher, which is a type approved as a hand-held extinguisher for aircraft use. The extinguishant contained is Bromochlorodifluoromethane (known as B.C.F.). In the test the extinguisher was discharged through a canopy aperture until the pressure was exhausted which took approximately 35 seconds. On opening the cabin door immediately the extinguisher was exhausted, and thrusting head and shoulders into the cabin, the first breath drawn was distinctly restrictive

and unpleasant and caused coughing. The restrictive and unpleasant effect quickly dissipated.

The B.C.F. extinguisher carries a Warning Notice 'The fumes given off can be dangerous in a confined space. Do not inhale. Ventilate directly after use.'

For health reasons the combined toxic effect of B.C.F. and material in combustion in a confined space was not carried out. (See paragraph 2.1.3 of this report).

1.16 Medical Aspects

Mr. Barton last underwent a medical examination for the renewal of his C.P.L. on the 15th November, 1972. On this date he was assessed as 'Fit for renewal of C.P.L.'

There was no history of any medical disability other than malaria. No postmortem could be carried out due to severe burning of the body.

2. ANALYSIS AND CONCLUSIONS

2.1 ANALYSIS

From ground investigation and from tests and research certain facts can be established.

- 2.1.1 (a) The angle of impact indicates that the aircraft was not being controlled during the final seconds of the descent. The failure to maintain control could be attributed to one of three main factors:-
- (i) Failure of a control system of the aircraft.
 - (ii) Structural failure.
 - (iii) The inability of the pilot to maintain control due to other circumstances.

Although the aircraft was completely destroyed it was possible to establish that certain sections of the flying control cables were intact. In addition no evidence of structural failure was found, although this cannot definitely be ruled out. It therefore seemed most logical that the third alternative, the inability of the pilot to maintain control should, in view of the other evidence available, be more closely examined, and this has been done in the analysis of evidence.

- (b) That at the time of impact the engine was either stopped or at the most turning very slowly. Although engine failure cannot be completely ruled out, this should not have resulted in the steep angle of impact seen at the accident site. As the ignition keys were not in the ignition selector, but were found in the ashes of the cabin, it is possible that the engine was deliberately stopped and

the keys removed. Normally ignition keys will remain in the switch even after high impact loads and subsequent fire, unless the ignition switch is selected to off, in which case the keys can be withdrawn. If the engine was deliberately stopped during flight, this would normally be for one reason only, that the engine condition was such that to stop the engine was presenting a lesser danger than to leave it running. Even after stopping the engine the pilot should have been in a position to execute an emergency landing under better circumstances than was the case in this accident, inless for some reason he was incapacitated.

- 2.1.1 (c) The adaptor from the fuel manifold (flow divider) to the rear left hand (no.2) cylinder had failed prior to impact and the initiation of this failure had probably been in existence for some while. The effect of the complete failure of the adaptor union was to allow fuel to be pumped on to the top of the engine crank case, which in normal circumstances would have had a light coating of oil on it, as the filler neck for the oil sump is only some eight inches forward of the fuel manifold. Oil topping up operations invariably result in minor oil deposits on the crank case top.

The effect of the fuel leakage due to the fractured union would have been to cause the engine to run roughly and with loss of power, and it therefore seems likely that a complete fracture of the adaptor did not take place prior to take-off from Dosi-Dosi, but occurred some few minutes later, by which time the engine and crank case temperatures had risen relative to a cylinder head temperature of between 300 - 460 degrees F. Under these circumstances there was a very real risk of fire, especially to electrical cables in the rear engine area. These cables were heavily charred forward of the engine bulkhead but cannot be definitely judged as pre-impact fire damage. This fire would probably first have appeared as smoke coming in under the instrument panel through bulkhead cuts-outs for electrical cables and pipelines.

2.1.2 Analysis Reconstruction

The reconstruction given here is a result of the analysis of the investigation details coupled with known facts and would appear to be the most likely circumstances to fit all the evidence available and give a reasonable explanation for the cause of the accident.

Since it can be shown that fuel leakage from the fuel manifold adaptor was most likely present prior to impact, then the evidence of ground witnesses that 'there was fire and smoke in the air' must be accepted as a probability. In the circumstances the pilot would have turned off fuel, switched off the ignition and used the fire extinguisher. If he had been overcome by the effects of the smoke/fire, combined

with the effects of the fire extinguisher, then at the time of impact the pilot would have no control of aircraft attitude. This would explain the high angle of impact and possibly account for the ignition keys not being in the ignition switch. The fact that the fire extinguisher could not be found could be accounted for by the pilot ejecting it through the side window in an effort to be rid of its effects. Had he broken a side window to throw out the extinguisher then the draught effect would have tended to suck the flame/smoke into the cabin at a greater rate.

2.1.3 ANALYSIS - Toxic Effect of Fire Extinguisher

Fumes from any combustion process are toxic, and the choice of a fire extinguishant is a compromise between the fire hazard and a possible increase in the hazard due to the toxicity of the extinguisher itself. The problem is one of selecting an extinguisher which reduces the total hazard the most, is the least toxic in combination with combustion, and yet is effective against the type of fire likely to occur.

Bromochlorodifluoromethane (B.C.F.) is particularly effective against electrical and flammable liquid fires. In contact with fire, it volatilises instantly. Of the vaporising liquids B.C.F. is less toxic than Chlorobromomethane (C.B.) or Methyl Bromide (M.B.) but it does nevertheless have toxic qualities and could be dangerous in a confined space. (see para. 1.15.2 of this report).

2.2 CONCLUSIONS

A. Findings

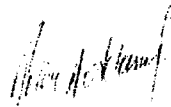
- i. That the documentation of the aircraft was in order.
- ii. That the aircraft had been properly maintained.
- iii. That the pilot was properly licensed.
- iv. That no evidence of structure failure or flight control failure was discovered, although this cannot be completely ruled out.
- v. That evidence was found indicating pre-impact failure of the adaptor from the fuel manifold to the left hand rear (No.2) cylinder fuel nozzle.
- vi. That at the time of impact the engine was almost certainly not under power.
- vii. That in the light of evidence from survey and research, the statement made by Masai witnesses to the effect that the aircraft was on fire prior to impact must be accepted as probably true.

B. Probable Cause

That the accident was probably caused by the failure of the adaptor from the fuel manifold to the No.2 cylinder fuel nozzle, which allowed fuel to be pumped on to a hot crank-case initiating an engine fire. That the pilot probably carried out an acceptable fire drill but was overcome by the toxic effect of a fire extinguisher combined with the effects of a combustion process, and was unable to regain control of the aircraft prior to impact.

RECOMMENDATION

That flight crew be advised through official publications of the dangers that can exist when the toxic effect of combustible material is added to, by the discharging of fire extinguishers in confined areas.



(P.J. ADAMS)
INSPECTOR OF ACCIDENTS

PJA/ZH

May, 1973