

ACCIDENT INVESTIGATION BRANCH
CIVIL ACCIDENT REPORT CAV/ACC/23/76

OPERATOR:

OPERATOR: Geosurvey International Limited
P.O. Box 30750, Nairobi, Kenya.

AIRCRAFT:

Type: Cessna
Model: 402B
Nationality: Kenyan
Registration: 5Y-ATM

PLACE OF ACCIDENT: 2 miles east of Fela Railway Station,
Tanzania.

DATE OF ACCIDENT: 18th September, 1976 at 1537 hours.

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

SYNOPSIS:

The aircraft took off from Mwanza Airport, Tanzania, to carry out a test flight for the purpose of compensating the Magnetometer equipment installed in the aircraft.

On completion of the calibration the aircraft headed back to Mwanza. An engineer seated in the front right hand seat noticed very dense white smoke trailing from the port engine, almost immediately the oil pressure gauge indicated a loss of pressure and the propeller was feathered shortly afterwards; the starboard engine began to lose power and the aircraft was unable to maintain a positive rate of climb, the pilot then elected to carry out a forced landing. On impact the starboard wing caught fire, after evacuation by the pilot and passengers the fire engulfed the major part of the fuselage and the mainplanes.

The report concludes that the accident was caused as a result of a combination of events that followed each other in rapid succession in which:

- (1) The port propeller was feathered due to an excessive oil leak and subsequent loss of oil pressure.
- (2) Failure initially to use the full power available from the starboard engine, followed by a loss of turbocharging.
- (3) The aircraft was operating at a low altitude above the ground, the surface of which was undulating and covered with large outcrops of rock.

1. FACTUAL INFORMATION

1.1. History of the flight:

The aircraft departed from Mwanza Airport at 1352 hours for the purpose of carrying out compensation adjustments to its magnetometer equipment in preparation for the commencement of an aerial survey the following day. There were three other persons on board and a flight plan was filed showing a planned duration of 2 hours. The main fuel tanks were full.

After completion of the compensation adjustments the aircraft headed back to Mwanza at an altitude of 400ft. During the return flight an electronics engineer seated in the right hand front seat noticed dense white smoke trailing from the port engine, almost simultaneously the port oil pressure gauge indicated a drop in pressure and the propeller was feathered.

The power on the starboard engine was increased to 34" Hg and 2,500 RPM and a rate of climb of 100-120 fpm was established at 115 mph IAS. When 25 nm south of Mwanza the rate of climb started to decrease and the manifold air pressure was observed to be 25" Hg with the throttle and pitch levers fully forward.

The pilot transmitted a MAYDAY call giving his position as 25 nm South of Mwanza at 1457 hours. Forty minutes later at approximately 1537 hours a report was received by the Air Traffic Controller at Mwanza, from Fela Railway Station, that an aircraft was seen to be flying at a low altitude and was observed to disappear from view in the undulating terrain. Shortly afterwards thick black smoke was seen from the position at which the aircraft was last seen. The site of the crash was approximately 2 nautical miles East of Fela Railway Station.

Both pilot and passengers were able to evacuate the aircraft without outside assistance. The pilot was slightly injured.

1.2 Injuries to Persons

<u>INJURIES</u>	<u>CREW</u>	<u>PASSENGERS</u>	<u>OTHERS</u>
Fatal	-	Nil	-
Non-Fatal	1	Nil	-
None	-	-	-

1.3 Damage to Aircraft

The aircraft structure was almost totally destroyed by fire. The tail area survived fire damage, but the tailplane and elevators were severely damaged during the forced landing by impact with small trees and shrubs.

Port Engine:- suffered serious fire damage, the engine compartment between the nacelle firewall and the rear cooling air seal was extensively damaged by fire.

Starboard Engine:- forward of the cooling airseal suffered only slight fire damage, but the engine compartment between the nacelle firewall and the cooling airseal was extensively damaged. Aluminium alloy parts in this area on both engines were completely destroyed.

1.4 Other Damage

The aircraft crashed and landed in bush country adjacent to cassava fields. Several rows of cassava were damaged in gaining access to the crash site.

1.5 Personnel Information

Commander: Age 42 years.
Licence: Commercial Pilot's Licence No. 1668 (K1499).
Aircraft Ratings
Group I: Cessna 180, 182, 185, 188, 205, 206, 207, 210, 310, and 402.
Piper PA 22, 24, 25, 28, 30 and 31
Beech B23 and 25
Airtruck, BN-2, DHC-1, DHC-2 and Mooney M20.

Certificate of Test: Valid until 26th November, 1976

Instrument Rating: Valid until 25th February 1977.

Medical Certificate: Valid until 14th November, 1976.

Flying Experience: P.1. - 10,179 hours
P.2. - 483 hours

1.6. Aircraft Information

5Y-ATM a Cessna 402B serial No. 402B 0445 powered by two Continental TS10-520-E engines and constructed by Cessna Aircraft Company, Wichita, Kansas, U.S.A.

The aircraft arrived in East Africa in possession of an FAA Export Certificate of Airworthiness No. E123537 issued on 9th October, 1973. An East African Certificate of Airworthiness No. 966 was granted on 27th September, 1973 valid until 26th September, 1974. This certificate has been renewed and was valid at the time of the accident.

Maintenance History - The aircraft was operated by Geosurvey International Limited and used for the purpose of conducting aerial surveys. It was maintained to Safari Air Services Schedule Ref: SAS/ALA/ISSUE 3 and all maintenance required by this schedule had been complied with. At the time of the accident the following hours had been recorded:-

Airframe total hours since manufacture	1458.30
" " " " last Check 3 (due at)	1600.00
" " " " " " 2	164.50
" " " " " " 1	16.30
Engine (Port) S/N 20 16506-E since manufacture	1235.35
" " " " " " overhaul	5.00
" (Stbrd) S/N 165909-E " manufacture	2540.06
" " " " " overhaul	5.00
Propeller (Port) S/N 715538 " manufacture	2473.10
" " " " " overhaul	164.05
" (Starb) S/N 713-052 " manufacture	2709.05
" " " " " overhaul	365.05

The port and starboard engines and turbochargers were overhauled by Safari Air Services and had been newly installed. The engines had been run-in on the ground for 5 hours before carrying out the first test flight. During this time a number of adjustments and rectifications were made, particularly involving the starboard turbocharger where an oil supply line was leaking and it was found that it was not developing its full pressure.

All Federal Aviation Administration Airworthiness Directives applicable to the aircraft, its engines, propellers and equipment had been complied with.

1.7. Meteorological Information

The weather in the Mwanza area on the afternoon of the day of the accident was reported as fine with a visibility of at least 10 kilometers. The surface wind was 8 knots at 008⁰m with a temperature of 27.5⁰ Centigrade and a pressure of 1014.9 millibars.

1.8. Aids to Navigation

Not applicable.

1.9. Communications

The MAYDAY call transmitted by 5Y-ATM was heard at Mwanza control tower who immediately informed the Central Police Station and telephoned the Area Control Centre at Nairobi.

1.10 Aerodrome and ground facilities

Not applicable.

1.11 Flight Recorder

Not applicable. The aircraft was not required to be fitted with a flight recorder.

1.12 Wreckage

The wreckage was substantially intact when it came to rest, but was almost completely destroyed by fire. The starboard main tank (tip tank) caught fire on impact with a small tree some 600 feet from the crash site. Flaming fuel was spilt from the ruptured tank over the area around the point of impact, causing a number of small fires in the grass. The port elevator and port tailplane main spar had separated from the structure and were found about 150 feet from the main wreckage.

1.13 Fire

Fire did occur, the starboard tip tank caught fire and spread to engulf practically the whole of the aircraft.

1.14 Survival Aspects

The pilot and passengers survived the accident with minor injuries. Before fire engulfed the aircraft, the cabin section with its equipment sustained the impact of the crash landing to the extent that the occupants were able to unfasten their safety belts and vacate the aircraft before the fire spread, despite a delay in opening the main cabin door.

1.15 Tests and Research

From the pilot's statement it was evident that the forced landing was necessitated by a loss of power on the starboard engine causing the rate of climb to decay following the failure of the port engine. The investigation of the engine defects was therefore centered on:

- (a) Port engine to determine the loss of oil pressure
- (b) Starboard engine to determine the loss of manifold air pressure.
- (c) The pilot's report stated: "The flight was uneventful until approximately 1752 hours when 47 nautical miles south of Mwanza, Mr. Cox observed oil streaming from the upper surface of number 1 engine." The upper surface in question was the upper cowl assembly cooling air exit. Examination was concentrated in the engine compartment of the engine cooling airseal, where engine laft oil pipelines from the oil cooler are routed to lubricate and control the engine turbocharger. Fire damage in this area was extensive with most of the aluminium alloy components of the fuel system destroyed, and the majority of the flexible pipelines of the oil and fuel system suffering extensive heat damage.

A comparison of heat damage caused to similar components installed either adjacent to each other or in close proximity was carried out. It was noticed that one pipe terminal fitting had not suffered the same heat damage as the other pipes in the same area. It was also discovered that one of the two flexible pipe connections to the oil cooler not more than one inch apart had suffered different forms of fire damage, in this case a soldered joint on one pipe having separated. The flexible pipe connected to the base of the oil cooler supplying engine lubricating oil to the turbocharger bearings was severely burnt and charred, whilst the flexible pipe fitted adjacent to this approximately one inch to the right, suffered less heat damage with no melting or distortion to the outer sleeve of the connector. A soldered joint had separated allowing the pipe to drop out of position.

A flexible pipe connector assembly similar to the 45° angle assembly in question was subsequently subjected to heat. The soldered joint connected to the threaded nipple separated and the connector was seen to soften and distort eventually cracking in several places. The surfaces of the joint were compared and in both cases showed a similar pattern of separation with the exception that the joint of the pipe found in the wreckage had a coke-like appearance due possibly to the heat of the fire after separation. The surface adhesion was good in both cases and revealed no pockets or inclusions. The connector under test revealed more heat damage than that found in the wreckage.

The oil cooler was subjected to a pressure test and the oil pressure filter casing was checked, there were no apparent defects.

(ii) Fire damage to the starboard engine was similar to that of the port engine, consequently it was not possible to check aluminium accessories and components in that area due to extensive fire damage. The turbocharger was removed and dismantled in a workshop to check for pre-crash failure but no defects were apparent. The engine was partially dismantled and inspected for mechanical failure but no defects were revealed. Both magnetos were inspected and one was bench tested, apart from fire damage no other defects were present.

The air intake and induction air system were severely damaged, the remaining sections that escaped fire damage were inspected and found to be satisfactory.

Performance:- The aircraft weight and balance at the time of the accident was stated to be 6,283 lbs. with a Centre of Gravity of 157 inches aft of the datum. At a power setting of 2,500 RPM/34.0 inches Hg and an air speed of 115 mph a rate of climb of 100-120 feet per minute was attained. When the aircraft reached an altitude of 700 feet A.G.L. the rate of climb began to decrease with the progressive decrease of manifold air pressure to 25.0 inches of Hg. A positive rate of climb was never restored although both throttle and propeller levers were fully forward.

An air test had previously been carried out on 13th August, 1976 for the purpose of renewal of its Certificate of Airworthiness. During the test a single engine performance climb (port engine inoperative) was carried out with the following results:-

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Mean Weight:	6175lbs.
Mean Altitude:	5800ft.
Mean Temperature:	ISA + 16.4°C
Observed R of C:	190 feet per minute
Scheduled R of C:	110 feet per minute
Indicated airspeed:	118 miles per hour
Engine RPM:	2700
Engine MAP:	34.5" Hg.

A number of single engine performance climbs were carried out on a Cessna 402B of the same production model as 5Y-ATM and the following results were attained:-

<u>Test</u>	<u>1st</u>	<u>2nd</u>	<u>3rd</u>
Mean weight	6300 lb	6300 lb	6300 lb
Altitude	4425 ft	4450 ft	4350 ft
Temperature	ISA + 19°C	ISA + 19°C	ISA + 19°C
Engine RPM	2500	2500	2700
Engine MAP	33.5" Hg.	25.8" Hg.	25.8" Hg
Observed R of C	83 fpm	-40 fpm	ZERO
Indicated airspeed	116 mph	116 mph	116 mph

The ground level of the area around Fela is estimated to be approximately 3,800 feet above sea level.

1.16 Medical Aspects

Not applicable.

2. ANALYSIS

2.1 Factors leading to the accident

To fully appreciate the circumstances of this accident, it is first necessary to make reference to the height above ground level and the topographical features of the area over which the aircraft was operating. The aircraft was engaged in the calibration and adjustment of its magnetometer equipment at an altitude of 400 feet above ground level. The area south of Mwanza is undulating country with massive outcrops of rock some of which are 100-150 feet above ground level.

The forced landing was a direct result of the loss of power on the single operating engine with the subsequent inability to maintain a positive rate of climb. From discussions with the pilot it would appear that the turbocharger was ineffective as the manifold air pressure gauge indicated that the engine was functioning in the normally aspirated mode, i.e. at 25.0 inches of mercury. Although the turbocharger was recovered and dismantled, no defects were revealed. The associated control pipes, valves, actuators, rear portion of the induction air system and the air intake assembly were all seriously damaged by fire. It has therefore not been possible to determine the nature of the defect associated with the loss of turbocharging.

With reference to the air test report which was conducted five days before the accident the aircraft achieved a better than scheduled rate of climb on the starboard engine, i.e. 190 feet per minute compared with the scheduled performance of 110 feet per minute. The results of a series of air tests conducted on a Cessna 402B of similar production standard to 5Y-ATM revealed that in this case the aircraft should have been capable of maintaining an altitude of 700 feet above the ground level at a power setting of 2700 RPM/25.0 inches of Hg. However, due to the decay of power from the starboard engine and the resultant loss of a positive rate of climb, the pilot was faced with the decision as to whether the flight should be terminated at the earliest possible moment or continue the flight to Mwanza on an estimated distance of 25 nautical miles south over undulating terrain with numerous outcrops of rock. It has also to be considered that the pilot having already feathered the port engine due to an excessive loss of engine lubricating oil was now faced with a second potentially serious situation, where the starboard engine was losing power and had not the time nor altitude to determine just how far the deterioration of power would continue.

When the propeller lever was placed fully forward the aircraft should, after the initial sink period, have at least maintained altitude and possibly attained a positive rate of climb. However, with unknown wind conditions it is impossible to guarantee the scheduled performance, and the close proximity of the ground would not favour reliance on such performance figures described by the manufacturer. Had the pilot selected full power on the starboard engine immediately after feathering the port engine, it is probable that the aircraft would have achieved a rate of climb consistent with the results of the air test performance carried out five days previously and would have been in a better position to handle the reduction in power from the starboard and maintain a positive rate of climb.

As it was, the aircraft achieved a rate of climb of 100-120 feet per minute with a power setting of 34 inches of mercury and 2500 RPM. With the reduction in manifold air pressure the rate of climb began to decrease to an extent that the pilot was unsure of the engine power available to maintain safe flight.

Both engines and turbochargers had been installed for only approximately seven hours since overhaul. There was no evidence of any mechanical failure in any of these components.

It was considered that the oil leak from the port engine would have most likely originated from that part of the engine lubricating oil system that supplied oil for the lubrication and control of the turbocharger or from the accessory case of the engine. Due to fire damage in this area it was not possible to locate this leak. The only clue that was considered worthy of investigation was the difference in fire damage to two flexible pipe connectors fitted to the oil cooler. The connection to the oil line supplying oil to the waste-gate actuator and control valves was found to have a soldered joint which had separated with no fire damage to the outer sleeve of the pipe. Whereas the pipe connection supplying oil to the turbocharger bearing suffered fire damage to the sleeve but the soldered joint did not separate. There did not appear to be any failure of adhesion of the solder to the metal. Both surfaces appeared to have a coating of solder although this had run during the head of the fire. No logical reason for the separation of the one joint could be established.

2.2 Loading

The load sheet for the flight showed a gross weight of 6123 lb with a centre of Gravity of 157.0 inches after of datum. To this loading must be added the weight of the fourth person on board (110lb.) plus an engineer's tool box of 50lbs. The amended weight and balance is calculated to be 6283lb. with a Centre of Gravity at 158.1 inches after of the datum.

The maximum gross weight authorised is 6300lb. Centre of Gravity at 6300lb. is 159.7 inches aft of the datum.

3. CONCLUSIONS

3.1 (a) Findings

1. The documentation of the aircraft was in order.
2. The aircraft had been properly maintained.
3. The pilot was properly licensed.
4. The aircraft weight and Centre of Gravity were within the prescribed limits.
5. The aircraft failed to maintain a positive single engine rate of climb due to a reduction in power from the starboard engine.
6. In the light of a combination of circumstances leading to the port propeller being feathered and a loss of power on the starboard engine the pilot was faced with a decision of -
 - (i) making an immediate forced landing or
 - (ii) attempt to reach Mwanza Airport flying over very rough terrain.
7. The most probable cause for the loss of engine lubricating oil from the port engine, was the separation of a soldered joint on the pipe connection to the oil cooler, which supplies oil to the waste-gate actuator and control valve. It was however, not possible to substantiate this point.
8. Due to fire damage it was not possible to determine the cause of the loss of control of the starboard engine turbocharger.

(b) Cause

The accident was the result of a combination of events that followed each other in rapid succession in which:-

- (i) The port propeller was feathered due to an excessive oil leak and subsequent loss of oil pressure,
- (ii) Failure to initially use the full power available from the starboard engine, followed by a loss of turbocharging.
- (iii) The aircraft was operating at a low altitude above the ground, the surface of which was undulating and covered with large outcrops of rock.


D.C. Stewart

CHIEF INSPECTOR OF ACCIDENTS