

MINISTRY OF INFRASTRUCTURE DEVELOPMENT

ACCIDENT INVESTIGATION BRANCH

CIVIL AIRCRAFT ACCIDENT No. CAV/ACC/15/05

**REPORT ON THE ACCIDENT TO CESSNA U206F AIRCRAFT
REGISTRATION 5H-APE WHICH OCCURRED ON 16 OCTOBER 2005
IN LUBULUNGU HILLS, MAHALE MOUNTAINS, KIGOMA,
WESTERN TANZANIA**

DRAFT FINAL REPORT

Ministry of Communications and Transport

Civil aircraft accident No: CAV/ACC/15/05
Aircraft type: Cessna U206F
Nationality and Reg. Marks: 5H-APE
Operator: Nomad Aviation Ltd
P.O. Box 681 Usa River
ARUSHA, Tanzania.
Crew: 1- killed
Passengers 4- killed
Place of Accident: Lubulungu Hills, Mahale Mountains
Kigoma, Western Tanzania.
(S 06 10.50 E 029 46.41)
Date: 16 October 2005
Time: 0935:18 hours (1235:18 pm Local Time)

ALL TIMES UTC

SYNOPSIS

The accident was notified to the Tanzania Accident Investigation Branch by the operator at 1500 hours on 17 October 2005. The investigations began on the same day.

The manufacturers of the airframe, the engine and the propeller took part in the investigation. They provided laboratory testing of some of the aircraft parts. The aircraft maintenance organization also took part in the investigation.

5H-APE took off from Mahale airstrip for a flight to Katavi National Park. It was carrying one pilot and four passengers. The aircraft was observed to climb over Lake Tanganyika and proceeded to fly south along the lake shore. It later circled above the operator's camp subsequent to which it was observed to fly into a valley between hills overlooking the camp. There were no radio transmissions from the aircraft. When the aircraft failed to arrive at Katavi search and rescue operations were initiated. The wreckage was later located on a hill side in the valley between Lubulungu hills some 18 km SSW of the Mahale airstrip. All the occupants were killed and the aircraft was completely destroyed by impact and the subsequent fire.

1. FACTUAL INFORMATION

1.1 History of the Flight

The aircraft was operating a charter flight to transport a party of four British tourists from Mahale National Park to Katavi National Park. Reports from eye-witnesses at Mahale airstrip said that shortly before the flight, the pilot de-fueled the aircraft. He down loaded 80 litres of avgas. A quantity of baggage belonging to the passengers was loaded.

A spokesman for the operator said that the aircraft was to fly under visual flight rules and the estimated time of arrival at Katavi was 1030 hours.

Take off for Katavi was initiated at 0922 hours. 5H-APE was observed to make a left turn and flew south along the shore of Lake Tanganyika. At 0931 hours 5H-APE circled over the operator's camp at Mahale at low altitude. The camp is located on the lake shore 15.6 km SSW of the airstrip. The aircraft subsequently flew into a valley between two hills overlooking the camp. There were no communications between the aircraft and the Dar es Salaam Area Control Centre. The aircraft was not equipped with HF radio.

When the aircraft failed to arrive at Katavi, the operator contacted a number of airstrips along the aircraft flight path to no avail. A search and rescue operation involving four aircraft was then initiated. At 1830 hours on that day one of the search planes, a Cessna182 registration 5H-ZGF spotted smoke coming out of a valley between two hills along the Lubulungu River. Further flights around the area established the presence of white pieces on the side of a hill, indicating the possibility of wreckage in that area. On the following day, 17 October 2005, smoke was no longer visible. However, ground search parties with help of spotter planes and markers, were able to spot the wreckage at 1530 hours (1830 hours local time). They were not able to access the site at the time due to night fall and the rugged terrain.

The ground search parties eventually arrived at the crash site at 0420 hours (0720 hours local time) on the following day. They ascertained that it was indeed the crash site and that there were no survivors.

1.2 Injuries to persons

INJURIES	CREW	PASSENGERS	OTHERS
Fatal	1	4	-
Serious	-	-	-
None	-	-	N/A

1.3 Damage to the aircraft

The aircraft was completely destroyed by impact with the ground and the subsequent fire.

1.4 Other damage

The forest surrounding the crash site was burnt.

1.5 Crew information

The pilot was born on 22 September 1976 at Montreal, Canada. He held a Tanzania Commercial Pilot's License No. HP-706 granted on 5 July 2005 on the strength of his FAA CPL No. 2675729 dated 2 June 2005.

The available documents show that by the time of the accident he had logged 2100 hours of which 381 were on the type.

He was rated on the *Cessna 206* in group I:

The family of the pilot said that he had accumulated a total flying experience of approximately 3000 hours. He had flown the following aircraft types: Cessna 206, from the northern most point of Canada to Cape Horn in Chile, the southern most point of the South America Continent.

1.6 Aircraft information

The aircraft, a Cessna U206F serial No. 01828 powered by one Continental IO-520F37B Engine was manufactured by the Cessna Aircraft Company at Wichita, Kansas, USA in 1972.

It arrived in Tanzania in possession of a Canadian Certificate Airworthiness No. 260038 and registration letters C - GDMM. The aircraft was registered in Tanzania on 5 March 1992 in the name of Greystock TZ Ltd, P.O. Box 1658 Dar es Salaam. A certificate of registration No. 354 was issued.

A certificate of airworthiness No. 321 (Public Transport Category) was issued on 18 March 1992 to expire 12 months later. The certificate of airworthiness had since been kept current through periodic renewals. By the time of the accident it was valid till 30 May 2006.

The aircraft was equipped with an... *STOL kit* and *wing tip fuel* tanks.

1.6.1 Weight and balance:

It was not possible to establish the exact weight of the aircraft at the time of take off. The commander did not leave behind any copies of his load sheet which could have shown his calculations for aircraft weight and balance before his departure from Mahale. All records in the wreckage were destroyed in the accident.

The operator provided mass and balance charts which indicated that the aircraft's gross take-off mass was 3800 lb. The aircraft was last weighed on 9 July 2001. Its mass (Empty weight) was found to be 2233 lb with an arm 36.43 inches yielding a moment of 81347 inch-pounds. Calculations for the aircraft take-off mass were based on the following assumptions:

1.6.1.1 Fuel

The aircraft was refueled to full tanks at Kigoma on the previous day. There were 80 US gallons of avgas in the main tanks and 30 gallons in the auxiliary tanks for a total of 110 gallons. The aircraft made a 45 minutes flight from Kigoma to Mahale on that day burning approximately 16 gallons. It was also reported that shortly before take off from Mahale the pilot drained some 80 litres (21 gallons) of fuel from the aircraft tanks.

1.6.1.2 Passengers and crew

The masses of the occupants were estimated at 170 lb for each of the males, 140 lb for each of the two of the females and 130 lb one female passenger.

1.6.1.3 Baggage

The baggage on the aircraft was estimated at 200 lb.

The mass of the aircraft at the time of take-off from Mahale was therefore calculated as follows:

	Mass	Arm	Moment
Empty mass	2233 lb	36.43 in	81348 in-lb
Oil qt	22	-0.55	-12
Fuel – Main 73gal	438	47.90	20980
Fuel – Aux	0	46	0
Pilot	170	37	6290
Co-pilot	170	37	6290
Centre left pax	140	70	9800
Centre right pax	140	70	9800
Rear right pax	130	100	13000
Baggage in cargo pack	120	67	8040
Cabin baggage	80	124	9920
Total	3590.8	47.75	171449
		C/G	

Maximum rate of climb for the aircraft at 36000 lb (as given by the Pilot's Operating Handbook) is as follows,

Sea level @ 59 deg. F 100 mph 920 feet per minute
 5000 feet @ 41 deg. F 96 mph 890 feet per minute

Interpolating the data for 2600 feet amsl and 50 deg F (standard Temperature) indicates the aircraft's performance at 98 mph would be approximately 780 feet per minute. The chart

indicates that there is a 30 feet per minute decrease in climb performance for each 10 deg. F above standard temperature and a 45 feet per minute decrease for the cargo pack. The temperature was reported to have been 82 deg F at the time of the accident. All these factors would have reduced the rate of climb to approximately 645 feet per minute.

The accident site was approximately 4.6 statute miles from the camp site, which the aircraft was observed over flying at about 3000 feet amsl. The accident site was approximately 4000 feet amsl, in a valley (canyon) that is narrowing. Given that the aircraft's maximum rate of climb was approximately 645 feet per minute at 98 mph, 5H-APE should have climbed to

approximately 4800 feet between the camp site and the crash site. The ridge line elevation on either side of the valley is between 6000 and 8000 feet.

1.7. Meteorological information

There is no weather station at Mahale. Eye witnesses who were interviewed at Mahale said that it was a bright sunny day. They estimated the temperature at the time of take off to be 28 degrees Centigrade. The relevance of the weather in this accident is that the relatively high temperature of the day had some bearing on the aircraft's rate of climb.

1.8. Aids to Navigation

Not applicable

1.9 Communications

Some aircraft in air in the area reported to have heard blind transmissions from 5H-APE shortly after take-off from Mahale airstrip. The transmissions were made on 118.1 Mhz.

No further transmissions were heard from the aircraft.

1.10 Aerodrome information

Mahale airstrip, elevation 2620 feet (799metres) has one runway (06/24) which is 900 metres long and 15metres wide. The runway is grass/murum. There is high ground about 1.5 km beyond the threshold of runway 06. Lake Tanganyika is located just beyond the end of runway 24.

The airstrip is owned by Tanzania National Parks.

1.11 Flight recorders

Not required by the Regulations. None fitted.

1.11.1 The GPS

The aircraft was carrying a GPS. It was a hand – held Garmin **GPS III PLUS**, serial No. 96529073. It was found outside the wreckage near the right wing. Damage to this equipment was confined to the antenna. Part of the antenna sheared off on impact. The unit had no evidence of fire damage.

The GPS was sent to the manufacturer for memory readout. The readout was made under the supervision of a United States FAA inspector.

There were 7 tracks retrieved (from the last 7 flights) which also included the accident flight. The track of the accident flight shows a departure from Mahale airstrip, down to the operator's camp. The aircraft made a pass over the camp, then circled once more after which it headed for the valley. The air speed at the beginning of the climb was 86 knots accelerating to 96 kt before starting to drop to 83 and then to 66. In the last four seconds the speed had decayed to 37 kt after the aircraft had turned through 147 degrees.

1.12. Wreckage information

The AIB inspectors arrived at the crash site on 19 October 2005. The wreckage was found on the slope of a steep, thickly wooded hill. The remains of the aircraft were all together at one place and extensively burned. This would rule out the possibility of an in flight break up. A large area of vegetation around the crash site was also burned.

There were some parts of the aircraft, which had separated in the accident sequence and were found close to the wreckage. These were the left horizontal stabilizer, part of the baggage pod, the engine, and the propeller.

Some parts of the wreckage including the GPS, the crank shaft flange, the oil filter and the fuel selector were recovered from the crash site and taken for further tests.

The bodies of the occupants were all found in the wreckage, burnt beyond recognition.

1.12.1 The propeller

The propeller, a Hartzell PHC-C3YF-IRF, was observed from a distance at its resting position on a rock just below the point of the main impact. At first it was not possible to access the propeller due to hostile terrain. All the blades were still on the hub. Part of one of the three blades was directly visible and was bent. It showed no direct signs of power at impact with the terrain.

However, when the propeller was recovered from its resting position on 17 November 2005, the remaining two blades had signs of rotational damage, *Appendix* The crank shaft broke following propeller strike and hence the relatively little on the propeller especially on one of the blades.

1.12.2 The engine

The engine, a Teledyne Continental IO-520F73B, serial number 830515-R was re-manufactured by Teledyne Continental Motors Inc, in April 2005. It arrived in East Africa with an export certificate of airworthiness number E396646 dated 28 April 2005. By the time of the accident the engine had done 330 hours.

The engine was examined at the crash site. It had suffered both impact and fire damage.

The crank shaft was broken at the forward end. A portion of the crank shaft flange which separated was retrieved for laboratory analysis.

This piece was examined at the Materials and Process Laboratory of Teledyne Continental Motors at Mobile, Alabama in the presence of the IIC. The laboratory tests established that:

- 1) The surface hardness met the print requirements.
- 2) The crankshaft propeller flange was fractured in overload.
- 3) There was no evidence of fatigue on *any* fracture surface.

There was shallow cracking across the front face of the flange. These cracks are typical of a propeller strike.

The oil filter, which was externally burnt, was cut for examination at the company AMO workshop at Nairobi. There were no signs of any metal particles inside the filter.

The oil sump was opened and examined at the crash site. There was burnt oil inside the sump.

There was no evidence of engine failure in flight. The available evidence points to sudden stoppage.

1.12.3 The fuselage

Much of the fuselage suffered impact and fire damage. From the marks on a tree on the crash site, it was evident that the left wing and horizontal stabilizer had collided with the tree, possibly deflecting the aircraft from its original track subsequent to which it collided with a rock on the hill side.

It was not possible to determine the exact configuration of the aircraft at the time of impact because of its near complete destruction. 5H-APE did not carry any flight recorders.

1.12.4 The fuel selector,

The fuel selector sustained external fire damage. It was opened at the operator's maintenance organization workshop. The positions of the valves were photographed and the pictures were sent to the manufacturer for determination of the selected position at the time of the accident.

The manufacturer determined the fuel selector position at the time of the accident as being on the left tank.

1.12.5 The flap actuator

Examination of the flap actuator showed that it did not exhibit any threads. This position, according to Cessna, indicates that the flaps were in the UP position at the time of impact.

1.12.6 The elevator trim tab

Measurements on the elevator trim tab control mechanism screw showed that the last 1.75 inches of the thread length was damaged as a result of impact. According to the manufacturer, this equates to 10 degrees tab up.

1.12.7 The wind shield

Pieces of the wind shield (wind screen) were examined at the crash site. There were no signs of breaking under localized impact load before the aircraft collided with the terrain. There were no traces of blood or bird remains on parts of the wind shield. There was no evidence of bird strike.

1.12.8 The GPS

The GPS, a Garmin *GPS III PLUS*, serial No. 96529073, was found outside the wreckage near the right wing. Damage to this equipment was confined to the antenna. Part of the antenna sheared off on impact. The unit had no evidence of fire damage.

The GPS was sent to the manufacturer for memory readout. The readout was made under the supervision of a United States FAA inspector.

There were 7 tracks retrieved (from the last 7 flights) which also include the accident flight. The track shows a departure from Mahale airstrip, down to the operator's camp. It made a low pass over the camp, then circled once after which it headed for the valley. The air speed at the beginning of the climb is 95mph and then begins gradually to drop down to 88 then 80 then 76. The last two points indicate a left turn with airspeed at 43 and mph.

1.12.9 The crash site

The aircraft came down in a valley between two steep and thickly wooded hills which form the banks of the Lubulungu River in the Mahale Mountains. A valley of this type is sometimes called a canyon. The vegetation is mainly tropical rain forest with heavy under growth. There are also some rocks and loose stones scattered on the banks of the river. This terrain makes access to the crash site particularly difficult.

The crash site is 4.5 km east of the Lake Tanganyika and about 7.5 km along the river in the Lubulungu hills. It is also about 18 km south of Mahale airstrip. The elevation of the crash site is 3860 feet (1176 metres).

1.13 Medical and pathological information

Not applicable

1.14 Fire

Fire broke out and consumed much of the wreckage. The vegetation around the crash site was also burnt.

1.15 Survival aspects

This accident was not survivable.

1.15.1 Injuries to persons

All the occupants were burnt beyond recognition.

1.16 Tests and Research

Laboratory tests were carried out on the crankshaft. The results are to be found in 1.12

2 ANALYSIS

5H-APE was in the process of making what appears to have been making one of those routine shuttles between two operator's camps in western Tanzania. Some persons interviewed at Mahale reported that flights took off from Mahale airstrip and flew south along the lake shore up to the operator's camp, circled above the camp, and then took heading for Mahale, climbing above the valley in the Lubulungu River. The valley offers a fantastic sight of tropical flora and fauna as well as the volcanic rocks of the Great Rift Valley. The Great Rift Valley extends from Syria running across the horn of Africa to Mozambique

In the accident flight the aircraft did not climb fast enough to remain above the rising terrain in the valley. Some of the factors governing the rate of climb are temperature and aircraft mass. The aircraft was being flown at around its maximum allowed take off mass and the pilot appears to have been aware of the potential danger of flying in the mountains at the obtaining conditions of temperature and aircraft loading. Shortly before take off he de-fueled the aircraft.

There was no reason for flying inside the valley on the Mahale-Katavi sector. The aircraft could well have climbed over the lake and should have gained sufficient altitude to clear the hills before taking heading for Katavi. Indeed after the accident all aircraft flying on this route were observed to climb over the lake after take off from Mahale.

There are no specific laws governing flights inside valleys in the country. There was no previous record of aircraft flying inside valleys in the country. Tanzania Civil Aviation Authority was not aware of any flights being conducted inside the Lubulungu valley.

The 12th schedule Section II (e) of the Tanzania Air Navigation Regulations 73(b) and 73(2) stipulates that:

An aircraft shall not fly closer than 500 feet to any person, vessel, vehicle or structure;

Section II (f) stipulates that:

No aircraft shall fly over National Parks, National Reserves or Game Reserves at a height of less than 1500 feet above ground.

Pilots who fly in the area were interviewed after the accident on the possibility of conducting flights inside the valleys. None of them supported the idea. In fact the *Chief*

Pilot of the Company said that he would not attempt flying inside the valley in Cessna 208. They raised the problem of climb performance of the Cessna 206 in hot environment at high altitudes. They also pointed to the dangers of encountering mountain waves.

The information down loaded from the GPS memory shows that 5H-APE made a normal take off and climb out of Mahale airstrip. The flight was normal till about 0933 hours at which time the aircraft was already inside the valley when the aircraft speed started decreasing. *It appears that pilot started trading speed for height because of the rapidly rising terrain in the area. This would indicate that at 95 mph the aircraft was not climbing fast enough to remain above the rising terrain inside the valley. The speed decayed further when a turn was initiated.*

In the circumstances it would have been more prudent to force land straight ahead in the valley than risk stalling through forced climb. Experience has shown that light single engine aircraft are more forgiving in forced landings than in stalls.

3. FINDINGS

- i) The aircraft was properly maintained and its documents were in order.
- ii) The pilot was properly licensed and qualified to undertake the flight.
- iii) The aircraft circled over the operator's camp at low altitude before flying into the valley.
- iv) The aircraft climbed inside the valley over rising terrain for nearly two minutes till it stalled and crashed.

Cause

The aircraft stalled and crashed during climb inside a valley. In the last minute of the flight the aircraft negotiated a turn over winding but rising terrain with decaying speed till it stalled.

The high take off mass and high ambient temperature of the day were contributory factors.

4 SAFETY RECOMMENDATIONS

It is recommended that:

- (i) TCAA should institute a separate Regulation that makes it illegal to fly inside valleys.
- (ii) Bush operators should carry weighing scales and request weights of individual persons.

J Nyamwihura
Inspector in Charge