MINISTRY OF INFRASTRUCTURE DEVELOPMENT

ACCIDENT INVESTIGATION BRANCH

CIVIL AIRCRAFT ACCIDENT No. CAV/ACC/15/08

DRAFT FINAL REPORT

ON THE ACCIDENT TO CESSNA U206F AIRCRAFT REGISTRATION 5Y-AOO WHICH OCCURRED IN THE SADDLE BETWEEN THE KIBO AND MAWENZI PEAKS OF MOUNT KILIMANJARO, MOSHI, TANZANIA

TANZANIA ACCIDENT INVESTIGATION BRANCH

Ministry of Infrastructure Development

Civil Aircraft Accident No. :	CAV/ACC/15/08.
Aircraft Type:	Cessna U206F.
Nationality And Reg. Marks:	5Y-AOO
Operator:	Luka Safari Ltd P.O. Box 236 Mtito Andei 90128 Kenya.
Crew:	1 - Seriously injured.
Passengers:	4 - Killed.
***Place Of Accident*:**	The saddle between the two peaks of Mt. Kilimanjaro. **Latitude: S 03^0 04.799'** **Longitude: E 037^0 25.659'** **Elevation: 14,339 feet**
Date:	8 November 2008.
Time	0700 hours (Approximately).

ALL TIMES UTC

SYNOPSIS

On 8 November 2008 at 0640 hours the aircraft took off from Kampi ya Kanzi Airstrip, Kenya for a sightseeing VFR flight along the line of Mt. Kilimanjaro. It was carrying one pilot and a party of four tourists. The pilot intended to fly to Loitokitok, proceeding to Amboseli before returning to Kampi ya Kanzi.

According to the pilot, the take off was normal and the aircraft climbed to 12,500 feet. Whilst cruising at this altitude alongside Mount Kilimanjaro, the aircraft was caught in a violent gust that initially pushed it upwards and towards the mountain. As he tried to steer the aircraft away from the mountain, he realized that the airspeed had decayed to 40 kt, indicating an imminent stall. He decided to dive in order to gain air speed. As he did so the VSI indicated a rate of sink of 2,000 feet per minute while the airspeed remained at 40 kt. Visibility was poor and the pilot did not see the ground till impact.

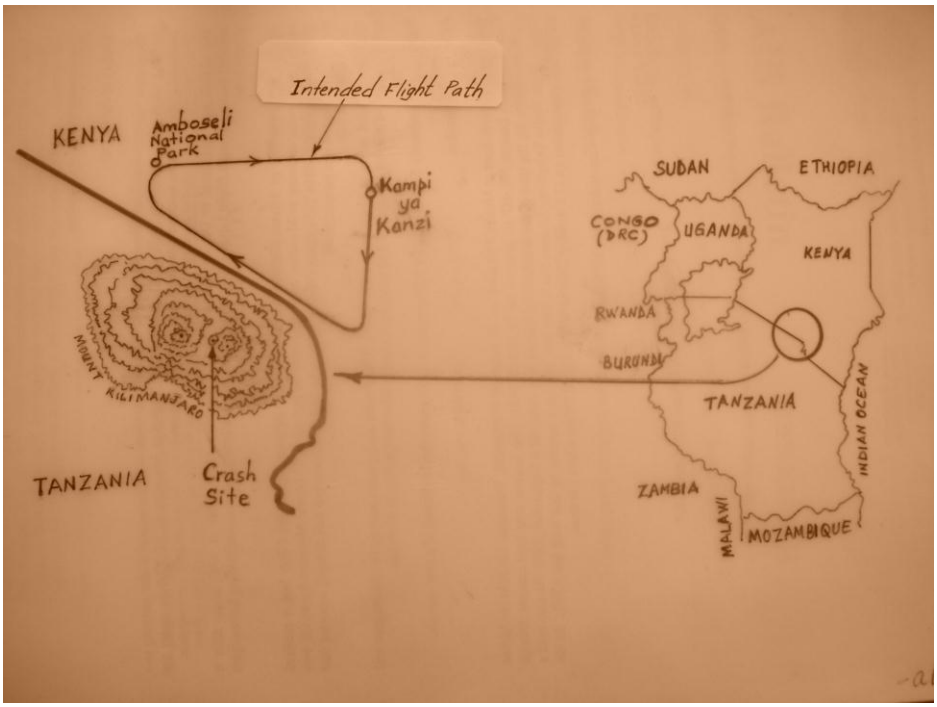
The pilot survived with a broken leg and a broken lower jaw but all the four passengers sustained fatal injuries. There was no fire but the aircraft was completely destroyed by the impact with the terrain.

The report concludes that the aircraft probably crashed as a result of the pilot losing control. Control was lost when strong winds caused a sudden gain in altitude followed by a rapid but uncontrolled descent

1. FACTUAL INFORMATION

1.1 History of the flight

The aircraft was operating a company charter flight to carry four Italian tourists for a scenic flight along the line of Kilimanjaro Mountain and the Amboseli National Park. It was flying under visual flight rules. 5Y-AOO took off from the operator's camp (Kampi ya Kanzi) in southern Kenya and was airborne at 0640 hours (9:40 am local time). The flight was expected to last 45 minutes.



When the aircraft failed to arrive at Kampi ya Kanzi Airstrip at the expected time, the operator thought that it had landed at one of the airstrips in the area because of the bad weather that had set in during the time when it was airborne. When all the airstrips in the area were contacted and the aircraft was not located, search and rescue operation was initiated by the operator. It was not until 0930 hours that the operator was informed about the accident by the Nairobi Area Control Centre.

At about 0700 hours on the morning of 8 November 2008 some tourists who were on the slopes of the Kibo wing of Mount Kilimanjaro observed a light aircraft descending towards the saddle between the two peaks of the mountain. The aircraft looked as if it was going to land. Moments later, they saw it crashing. They alerted a nearby camp that is owned by the Tanzania National Parks. When rescue parties from the camp arrived at the crash site, they found the pilot lying on the ground outside the wreckage. He was unconscious. The four passengers were still inside the wreckage but there was no indication of life. There was no fire but the aircraft was completely destroyed by the impact with the ground.

The pilot was taken to KCMC Hospital in Moshi where he made a fast recovery. His left leg was broken as well as his lower jaw. The four bodies of the passengers were extricated from the wreckage and were transported to Moshi on the following day.

The pilot himself testified that takeoff from Kampi ya Kanzi airstrip was normal. He intended to fly along the line of Mount Kilimanjaro from Kampi ya Kanzi in the Chyulu Hills to Loitokitok and then to cruise along the line of Mount Kilimanjaro. He thereafter was to proceed to Amboseli national Park for the tourists to see elephants before flying back to the airstrip. His cruising altitude along the line of the mountain was 12,500 feet.

The passengers were Italian tourists on holiday at the camp. They wanted to see and photograph the Mountain and do the scenic tour before leaving for Italy via Nairobi. The flight to Nairobi was due to takeoff at around 0730 hours. Another aircraft was waiting for them at Kampi ya Kanzi.

Whilst cruising at 12,500 feet alongside Mount Kilimanjaro, the aircraft was caught in a violent gust that initially pushed it upwards at 2,500 feet per minute and towards the mountain. As the pilot tried to steer the aircraft away from the mountain, he realized that the airspeed had decayed to 40 kt, indicating an imminent stall. He decided to dive in order to gain air speed. As he did so the VSI indicated a rate of sink of 2,000 feet per minute while the airspeed remained at 40 kt. He selected 10^0 of flaps and then full flaps whilst applying full power to no avail. Visibility was poor and the pilot did not see the terrain till impact.

1.1 Injuries to persons

Injuries	Crew	Passengers	Others
Fatal	-	4	-
Serious	1	-	-
None	-	-	N/A

1.3 Damage to the aircraft

The aircraft was completely destroyed by the impact with the terrain.

1.4 Other damage

There was no third party damage.

1.5 Personnel information

The pilot

Age:	38 years.
License:	Kenya Commercial Pilot's License.
Last medical examination:	16 May 2008.
Total flying experience:	1,800 hours.
Total experience on the type:	1,200 hours.
Aircraft ratings:	Endorsed for Cessna 206, PA28.

1.6 Aircraft information

The aircraft, a Cessna U206F serial number 206-01710 powered by one Continental IO 520F-73B engine, was manufactured by the Cessna aircraft Company at Wichita, Kansas, USA in 1971.

Ownership History

The aircraft arrived in Kenya in 1971 and was registered in the name of Safari Air Ltd, P.O. Box 41951 Nairobi, Kenya. A Certificate of Registration No. 692 was issued on 10 November 1971.

The subsequent ownership was as follows:

Date	**Owner**	**Address**
21 August 1972	Gailey and Roberts Ltd.	P.O. Box 30067 Nairobi
3 July 1976	Kelvin Air Services.	P.O. Box 30750 Nairobi
13 February 1979	George Forno.	P.O. Box 20442 Nairobi
6 December 1988	Brian Shepard.	P.O. Box 42730 Nairobi
1 November 1994	Michael Vladmir Nicholas Seton.	P.O. Box 42730 Nairobi
28 August 2001	Luka Safari Ltd.	P.O. Box 236-90128 Mtito Andei, Kenya

Airworthiness

A Certificate of Airworthiness (C of A) No. 682 was issued on 29 November 1971. The C of A has since been kept current through periodic renewals. By the time of the accident the C of A was valid till 31 October 2009.

By the time of the accident the aircraft had flown a total of 7,982 hours since new and the engine had done 852 hours since overhaul.

1.6.1 Weight and balance

The estimation of the aircraft mass at the time of takeoff was based on the fuel endurance of 03:00 hours which translate to 262 lb. There were three male persons estimated at 80 kg each and two female passengers at 75 kg each. The estimate for the total mass of the 5 persons on board the aircraft was therefore 390 kg or 860 lb. The last aircraft weighing report gives the empty weight as 2170 lb. The takeoff mass was therefore estimated as follows:

	Mass (lb)	Arm (in)	Moment (lb-in)
Aircraft empty mass	2170	34.5	72657.0
Fuel (165 litres)	262	47.9	12549.8
Pilot and passenger (Front row)	350	37.0	12950.0
Centre passengers	340	70.0	23800.0
Aft passenger	120	100.0	12000.0
Cargo pack	0	127.0	0.0
Estimated takeoff mass	3242	41.3	133956.8
Maximum allowed takeoff mass	3600		

C of G limits & maximums are:
@2500lbs or less +33 to 49.8 inches
@3600lbs +42.5 to 49.7 inches

Maximum allowed takeoff mass: 3600lbs

1.7 The weather

There is no weather station at Kampi ya Kanzi. The owner of the camp, who is also a pilot, said that they obtain METAR weather information on the internet. During the inspector's visit, he demonstrated how to obtain the Metar weather report for Jomo Kenyatta International Airport in Nairobi. The owner of the camp (Kampi ya Kanzi) said that for flights to Nairobi's Jomo Kenyatta and Wilson airports, the destination weather is obtained by contacting the actual destination using the company satellite phone. The actual weather at the time of take off from Kampi ya Kanzi is obtained by physical observation.

The en-route weather is normally obtained by contacting aircraft already in the air. At the time of takeoff from the airstrip it was a clear day with scattered clouds. The forecast for the general area was that of a clear morning with scattered cloud followed by showers later on during the day.

It was further reported that shortly after takeoff the weather deteriorated rapidly. The pilot reported that he encountered some rain when flying over Loitokitok. However, there was no rain at the time of the accident.

1.8 Aids to Navigation

The aircraft was equipped with a Garmin 430 GPS which enabled the pilot to track its intended route accurately. It also showed the location of the mountain and the Kenya-Tanzania boarder.

1.9 Communications

There is no record of the aircraft having established communications with any of region's control centres for the 20 minutes it was airborne. There was also no mayday call.

The operator of the camp reported that shortly after becoming airborne at 0640 hours, the pilot raised the camp on the company frequency (163.425 MHz) and advised that he was expecting to land at 0725 hours. The pilot himself said that he did not communicate with any control centre for the time that he was airborne. He reported to have made a blind transmission on 118.0 MHz giving departure from Kampi ya Kanzi 0636 hours, fuel endurance as 3 hours, Flight Level 125. This transmission was picked by one aircraft that was in the air at the material time.

When the aircraft failed to return as expected, the operator requested a Cessna 208, 5Y-BLN that was in the area to make a call on the aeronautical frequency of 118.0 MHz. No answer was received. Another call was made on 118.05 MHz to no avail. 5H-BLN was subsequently requested to call all pilots in the area and request them to look for 5Y-AOO who was then overdue. There was no finding.

The operator subsequently initiated search and rescue action. The East African Air Charters Company in Nairobi was raised by means of a satellite phone and they agreed to send two aeroplanes as soon as the weather cleared.

It was not till 1245 hours when the Kenya Police received information by telephone from their Tanzania counterparts that an aircraft had crashed on Mt. Kilimanjaro between Mandara and Horombo. These locations are staging points for climbers of the Kilimanjaro Mountain.

1.10 The crash site

1.10.1 Point of impact

The aircraft crashed on a fairly level ground on a plateau about 2 km west of the foot of the Mawenzi wing of Mount Kilimanjaro. The surface is volcanic dirt with scattered stones. The elevation of the position of the wreckage is 14,339 feet. The weather in the area around the crash site was reported to be variable. When inspectors of accidents visited the area on the following day the weather was observed to change after very short intervals. In a matter of 15 - 20 minutes, a warm sunny day would turn to be chilly and foggy. The fog would disappear only minutes later.

1.10.2 Mount Kilimanjaro

Mount Kilimanjaro is a dormant volcano mountain whose summit is 19,340 feet (5,895 meters), is the highest on the African continent. It sits on the north-eastern tip of Tanzania. The country just across the border is Kenya.

1.10. Air Accidents on Mt. Kilimanjaro

Our records show that there have been only two fatal air crashes on Mount Kilimanjaro:

1. On 18 May 1955 an East African Airways DC-3 collided with the Mawenzi wing of the mountain at 15,200 feet in bad weather, killing all the 20 persons on board. The aircraft was en-route Dar es Salaam-Nairobi. There were no survivors. The accident aircraft had last reported to be cruising at 10,500 feet under visual flight rules.

2. On 1 November 1997 a Piper PA 31-350 en-route Nairobi-Zanzibar crashed on the Kibo wing of Mt. Kilimanjaro at 15,400 feet in bad weather. The wreckage was found 30 nautical miles west of the track. The pilot, who was the only occupant, was killed in the accident. The aircraft had previously raised Kilimanjaro Approach and requested clearance to climb from 9,500 feet to 11,500 feet. The aircraft was cleared to climb 11,500 feet but there was no further transmission from the aircraft.

   The aircraft remained missing for six years till it was accidentally sighted by a mountain climber in 2003. The aircraft remained invisible because of the snow at this altitude. It became visible when the snow started melting.

1.10.3 Other Accidents related to Mountains in northern Tanzania and Kenya

On 16 March 2001 a Cessna 206 collided with the ground during cruise after being caught in a down draft in Mbulu District, northern Tanzania. All the five occupants were seriously injured in the accident.

On 21 January 2005 a Cessna 150 crashed at Ngong hills near Nairobi after being caught in a strong downdraft that exceeded its climb capability. All the two occupants lost their lives. Eye witnesses reported that the aircraft was pushed backwards by the wind.

The regions of north-eastern Tanzania and the bordering regions Kenya that are located in the neighbourhood of the Kilimanjaro range of mountains are frequented by international tourists because of wild life, beautiful lakes and famous mountains. For this reason, there are significant flying activities in these regions, most of them using light aircraft.

1.11 Wreckage information

The wreckage was found lying upside down on arid land on the saddle between the two peaks of Mount Kilimanjaro. Examination of the crash site showed that the first contact with the ground was made by the propeller, indicating that the aircraft was in a steep dive at the time of impact. It subsequently pivoted on the nose and tipped on its back, coming to rest 43 meters beyond the point of the first impact.

The propeller separated and was located near the main wreckage. Two blades of the propeller showed signs of bending in the direction of rotation, indicating that the aircraft was under power at the time of impact.

Both wings were partially detached from the fuselage and were extensively damaged by the impact with the ground. There was no evidence of fire damage. The flaps were fully down.

The engine, a normally aspirated Continental IO-520F, was still attached to the fuselage.

The cockpit and much of the front fuselage section were extensively damaged. The throttle was found in the maximum power position and the mixture was at full rich. The propeller was set in the full pitch position.

The rear fuselage sustained minor damage while the tail plane showed impact damage on the right horizontal stabilizer and the tip of the fin

1.13 Medical and pathological information

Not applicable.

1.14 Fire

There was fuel spillage but there was no fire.

1.15 Survival aspects

The pilot was the only survivor in the accident**.** He was ejected from the aircraft in the accident sequence. He was found lying unconscious besides the main wreckage. The pilot was rescued by competent mountain rescue parties shortly after the accident. This probably contributed to his survival. He could possibly have died from exposure or excess bleeding.

This accident is not considered to be survivable although the pilot survived with serious injuries.

1.16 Tests and research

Not applicable.

1.17 Mountain waves

Mountain waves occur on the lee side of mountains. They normally occur when wind-flow is strong, 25 knots or more and the flow is roughly perpendicular to the mountain range. On the windward side of a mountain the air flows up the mountain fairly smoothly with a lifting component as it moves along. The speed gradually increases, reaching a maximum near the summit. On passing the crest, the flow breaks down into a much more complicated pattern with downdrafts predominating.

Such winds are known to induce the formation of peculiar types of clouds. These clouds are lens-shaped and are called "*lenticular clouds*". The presence of mountain waves is often exhibited by the formation of these lenticular clouds which are stationary, constantly forming on the windward side and dissipating on the lee side of the wave.

2. ANALYSIS

2.1 Circumstances of the accident

The aircraft was supposed to fly a route that was in form of a right angled triangle with the longest side parallel to the line of Mount Kilimanjaro and three nautical miles north east of the Tanzania boarder. All the flying was planned to be inside Kenya. However, the wreckage was found to be 12 nautical miles (22 km) off the track and inside Tanzania. It was resting on Mount Kilimanjaro at 14,339 feet.

The circumstances of the accident and the examination of the wreckage did not point to any technical problem with the aircraft which could have contributed to the accident. All the significant structural parts of the aircraft were accounted for at the accident site. The possibility of an in-flight breakup was therefore ruled out.

The pilot himself reported that he was cruising at 12,500 feet inside Kenya parallel to the line of Mount Kilimanjaro when he was caught in a gusting wind that took him upwards as well as towards the mountain. Effort to steer the aircraft away from the mountain failed. It is not known how high and how close to the mountain the aircraft eventually reached before he dived to earth. This is because the aircraft had no flight data recorder. The GPS on board the aircraft had no memory. However, since the aircraft crashed at an attitude of 14,339 feet from a dive, it should have descended from a higher altitude. It is quite possible that the aircraft was blown over the peak of the Mawenzi peak (elevation 16,893 feet) by an updraft and then was subsequently swept down in a downdraft.

It is unlikely that the aircraft would have made a normal climb to such altitude in the 20 minutes that it was airborne, given that the engine was not turbo charged and the aircraft, carrying 5 persons and 3 hours fuel, was heavy. In any case there was no reason for climbing to such altitude without oxygen.

It is therefore very likely that 5Y-AOO was caught in a mountain wave that caused the sudden altitude gain and the abrupt descent.

The reason for climbing to the highest altitude for unpressurised aircraft (12,500) feet appears to have been to allow the passengers to see Mt. Kilimanjaro clearly. It is a common experience for passengers to request pilots to fly as near as possible some to a mountain they want to photograph. However, it is incumbent upon the pilot to keep a safe distance from the requested terrain considering the potential hazards associated with mountain flying.

2.2 *Hypoxia*

Among the hazards associated with high altitude flying for unpressurised aircraft are the effects of hypoxia. Hypoxia is a pathological condition in which the body is deprived of adequate oxygen supply. The occupants of unpressurised aircraft not carrying oxygen risk developing hypoxia leading to altitude sickness.

Hypoxia usually develops without the affected person being immediately aware of the condition. It is therefore possible that hypoxia could have affected the pilot's judgement of the distance from the mountain.

2.3 Air crashes on Mt. Kilimanjaro

The two fatal accidents on Mount Kilimanjaro in 1955 and 1997 were each attributable to controlled flight into terrain in conditions of poor visibility. The wreckage of the DC-3, which was supposed to be flying VFR at 10,500 feet, hit the Mawenzi wing at 15,200 feet. The wreckage of the Piper PA 31-350 was found at 15,400 feet on the Kibo wing. It was also 30 nautical miles west of its projected track. The aircraft had earlier been cleared to climb from 9,500 feet to 11,500 feet under visual flight rules.

It was not established whether the climb from cruise level to high altitude in each case were initiated by the pilots in effort to clear high ground ahead or some mountain wave activity contributed to the sudden climb. However, in the light of the accident to 5Y-AOO, and the similarity of these accidents, there is need to conduct specialist investigation into the possible contribution of winds associated with the mountain.

3. CONCLUSIONS

(a) *Findings*

(i) The aircraft had been issued with a valid certificate of airworthiness and had been maintained in accordance with an approved maintenance schedule.
(ii) The pilot was properly licensed and qualified to undertake the flight.
(iii) The aircraft documents were in order.
(iv) The aircraft had no ELT.
(v) Whilst cruising at 12,500 feet, the aircraft was caught in gusting winds which caused the pilot to lose control.
(vi) The aircraft crashed in the saddle between the two main peaks of Mount Kilimanjaro.

(b) *Cause*

The aircraft crashed as a result of the pilot losing control. Control was lost when strong winds associated with the mountain caused a sudden gain in altitude followed by a rapid but uncontrolled descent in bad weather.

SAFETY RECOMMENDATIONS

It is recommended that:

1. TCAA and KCAA should issue safety advisory notices to remind pilots about the hazards of flying close to mountains.

2. Pilots of non-pressurised aircraft should adhere to the limits of altitude in order to hypoxia attacks to aircraft occupants.

3. The Kenya CAA should ensure that all aircraft are fitted with dual frequency ELT in accordance with the provision of ICAO Annex 6 of the Chicago Convention.

4. The Meteorological agencies of Tanzania and Kenya should explore the possibility of establishing weather station around Mount Kilimanjaro with the purpose of exploring mountain wave activities and their potential hazards to aviation.

5. The operator should ensure that his aircraft maintain communications with the relevant control centres during all operations.