

MINISTRY OF COMMUNICATIONS AND TRANSPORT

ACCIDENT INVESTIGATION BRANCH

CIVIL AIRCRAFT ACCIDENT NO.CAV/ACC/1/96

REPORT ON THE ACCIDENT TO CESSNA 172 AIRCRAFT REGISTRATION 5H-BIG
WHICH OCCURRED ON 18 JANUARY 1996 AT KAZIMZUMBWI VILLAGE KISARAWA
DISTRICT TANZANIA (0703S 3858E)

AIRCRAFT ACCIDENT REPORT NO CAV/ACC/1/96

AIRCRAFT : Cessna 172

ENGINES : One Continental IO - 360-H

REGISTERED OWNER : Coastal Travels Ltd
P.O. Box 3052 DAR ES SALAAM

OPERATOR : Same as registered Owner

CREW : One - Uninjured

PASSENGERS : One - Uninjured

PLACE OF ACCIDENT : Kazimzumbwi Village, Kisarawe District
About 12 minutes flying time from
Dar es Salaam (0703S 3858E)

DATE AND TIME : 18 January 1996 at 1308 hours

ALL TIMES UTC

SYNOPSIS

The aircraft took off from Dar es Salaam at 0735 hours. It was carrying one pilot and three passengers. It landed at Siwandu at 0816 hours and took off for Kiba at 0832 hours. The aircraft was refuelled to full tanks at Kiba. It took off at 0835 hours and landed at Ruaha at 1020 hours. At 1037 hours 5H-BIG took off for Dar es Salaam.

The Pilot reported that he had been using the right tank all the way from Kiba. At 1145 hours when he was cruising at 11,500 feet the right tank was exhausted and the left tank, which was then full, was selected. About 30 minutes later the left tank gauge was reading less than half full. The gauge needle was subsequently observed to move unusually fast and was reading zero at 1259 hours. The engine stopped shortly afterwards. The aircraft made a successful force landing on a road at Kisarawe. There were no injuries and the aircraft sustained a dent on the right wing.

1. FACTUAL INFORMATION

1.1. History of the flight

The aircraft was operating a Company scheduled flight covering sectors DAR ES SALAAM/SIWANDU/KIBA/RUAHA/DAR ES SALAAM. Shortly before take off the aircraft was refuelled to full tanks at Dar es Salaam and extra fuel (40 litres) were carried in two jerry cans.

The aircraft took off from Dar es Salaam at 0735 hours. It was carrying one pilot and three passengers. The flight to Siwandu was uneventful and the cruising altitude was 6,500 feet (1980m). It landed at Siwandu at 0816 hours. Two passengers disembarked here and the aircraft took off for Kiba at 0822 hours.

5H-BIG landed at Kiba seven minutes later. The aircraft was refuelled here from the two jerry cans which had been loaded at Dar es Salaam. About two litres of fuel remained in the second jerry can after the right tank (which was being used for the flight from Dar es Salaam) had become full to the brim. Two passengers joined the flight and the aircraft departed at 0835 hours.

The pilot said that he climbed to 10,500 feet in order to avoid mountains en route. At 1020 hours the aircraft landed at Ruaha. The pilot reported to have smelt fuel in the cockpit during the approach and landing at Ruaha. He also said that it had been a higher than normal approach.

Two passengers disembarked at Ruaha and the aircraft took off for Dar es Salaam at 1037 hours. It was carrying one pilot and one passenger. 5H-BIG climbed to 11,500 feet using the same RIGHT TANK till 1145 hours when the tank was exhausted and the left tank was then selected. At this time the aircraft was flying over Mikumi. The Pilot said that the fuel gauge for the LEFT TANK was reading FULL when the tanks were switched.

At 1230 hours when the aircraft was abeam Ngerengere the tank indication was between $\frac{1}{2}$ and $\frac{1}{4}$. From then on, the pilot said, the fuel gauge needle moved unusually fast and was reading zero by 1259 hours. Since the engine had continued to operate normally on the RIGHT TANK for 30 minutes when the fuel gauge was reading zero, the pilot thought that the fuel gauge could not be trusted and the flight to Dar es Salaam could be continued for the remaining several minutes. The engine, however, stopped almost immediately after the zero fuel reading. By this time the aircraft was between Kisarawe and Mzenga Railway Station.

The pilot subsequently informed the Dar es Salaam Approach that he was force landing on the Kisarawe/Mvuha road and gave his position as (0703S 3858E). 5H-BIG subsequently executed a successful force landing on a stretch of an unpared road at Kazimzumbwi Village at 1308 hours. The two occupants disembarked safely.

Another aircraft, 5H-RHS, took off from Dar es Salaam 15 minutes later and confirmed the position of the aircraft.

Examination of the aircraft fuel tanks showed that there was no fuel in both tanks. The two fuel corks were found properly tightened.

When 20 litres of fuel were added in each of the two tanks there were no fuel leaks. After a successful engine run on the ground the aircraft took off for Dar es Salaam at 1520 hours. It landed at Dar es Salaam at 1533 hours.

1.2. Injuries to persons

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

1.3 Damage to aircraft

The right wing was dented when it struck a small tree on the side of the road during the landing roll.

1.4 Other damage

There was no third party damage.

1.5. Crew information

The pilot, captain James Lema NKKO was born at Arusha Tanzania on 24 December 1953. He held a Commercial Pilot's Licence No. HP 10 granted in 1978.

By the time of the accident he had logged 10900 hours most of which were on twins. His experience on the type was about 100 hours.

He had the following ratings to his Licence

Group 1

Cessna 172, 210, 310, 337, 402,
Piper PA 23, 32

1.6 Aircraft information

The aircraft, a Cessna FR 172J Reims Rocket serial number FR 172-0420 powered by one Continental 10-360-H4B engine was manufactured by the Reims Aviation, France in 1973.

It was first registered in Tanzania on 6 March 1982 in the name of Builders (V. M. Chavda) Ltd P.O. Box 831 Dar es Salaam. A Certificate of Registration No.119 was issued.

A Tanzania Certificate of Airworthiness No. 226 was issued on 3 April 1982 to expire one year later. By the time of the accident the C of A was valid till 21 March 1996.

1.6.1. Loading and C of G Disposition

From the available evidence, the aircraft was correctly loaded in terms of weight and the centre of gravity was within the allowed limits.

1.6.2. Fuel

The aircraft was refuelled in Dar es Salaam prior to the commencement of the scheduled flight. The pilot supervised the refuelling.

It was not possible to establish the quantity of fuel available in the aircraft tanks just before it was refuelled. However from the refuelling records, a British Petroleum receipt No. 5687 dated 18 January 1996, some 168 litres of Avgas were supplied to the aircraft for the flight to Siwandu. According to eye witnesses, fuel was pumped into the tanks till it overflowed in both tanks. The remaining 40 litres were filled in two jerry cans which were loaded in the cabin.

The pilot said that he flew the forward leg of the flight with the fuel selector positioned on the RIGHT TANK. More fuel was added to the right tank at Kiba. When fuel overflowed during the refuelling process there were about two litres remaining in the second jerry can.

For the first 10 minutes of the flight to Ruaha the "BOTH TANKS" position of the fuel selector was used, after which the fuel selector was positioned on the RIGHT TANK.

The aircraft climbed to 10,500 feet for the flight to Ruaha and cruise leaning gave 8.5 gallons per hour, according to the pilot. He also reported to have smelt fuel in the cockpit on arrival at Ruaha. 5H-BIG took off from Ruaha using the RIGHT TANK which was maintained for 1.08 hours. When the RIGHT tank was eventually exhausted at 11.45 hours the LEFT TANK was selected at a cruising altitude of 11500 feet. The cruise fuel flow was reported by the pilot to be 8 gallons per hour. At this time, the pilot said, the fuel gauge was indicating FULL fuel and the distance remaining was 130n.m. The pilot expected to cover this distance in 1.15 hours so that his ETA was estimated at 1300 hours.

At 1230 hours when the aircraft had flown only 45 minutes on the LEFT TANK the gauge was indicating between $\frac{1}{2}$ and $\frac{1}{4}$ full. The pilot said that this led him to believe that the gauge was itself a suspect. This was given more weight by a previous observation when the RIGHT TANK gauge was reading EMPTY for 30 minutes but fuel was flowing normally. However he took a precaution of delaying the descent on Dar es Salaam which should have started at 1235 hours.

After 1235 hours the fuel gauge needle, according to the pilot, moved unusually fast and was reading EMPTY by 1259 hours. The engine stopped at the same time.

1.6.3. Estimation for fuel uplift

The pilot said that his estimation for fuel was based on the figures given in the flight manual. Cruise performance figures at 10,000 feet for an aircraft of 1157kg gross weight at zero wind and standard conditions the aircraft endurance should be 6.1 hours, range 695 nautical miles at 114kt. This, he said, was more than enough for the 3.55 hours flight from Kiba to Dar es Salaam via Ruaha. The extra take off from Ruaha could not significantly change the figures.

Consideration was also given to the basic fuel flow figures. Cruise fuel burn was between 8 and 8.5 U.S. gallons per hour, according to the pilot. However, for the purpose of estimation of the total fuel requirement a basic rate of 9 gallons per hour was used.

For the estimated total flying time of 3.55 hours (KIBA/RUAHA/DAR) at 9 g.p.h. the fuel burn should be just under 36 gallons.

Since the aircraft was last refuelled to full tanks at Kiba (49 gallons) out of which 3 were unusable, the usable fuel was 46 gallons. The remaining 10 gallons were equivalent to more than one hour flying time required for diversion to alternate and 30 minutes holding.

In the company operations manual calculation for fuel burn is based on five items.

- (a) Fuel for run up and taxi
- (b) Fuel to be used en route based on forecast conditions
- (c) Fuel for 45 minutes holding at destination
- (d) Fuel required to divert from decision height at scheduled destination to specified alternate.

Minimum allowable distance is 100n.m, UNLESS the forecast weather at destination and alternate are above company minima for the period three hours before and after ETA at destination, in which case minimum allowable distance is 50 n.m.

- (e) Fuel for contingencies being 10% of (b) and (d)

1.6.4. Calculation for fuel burn

In order to estimate the actual fuel burn for the KIBA/RUAHA/DAR trip, calculations were made using the empirical data as follows:

DAR - SIWANDU	41 Minutes
SIWANDU - KIBA	<u>7</u> Minutes
TOTAL	48 Minutes

Given that the RIGHT TANK (used for the trip) was full at Dar es Salaam and had to be topped up with two jerry cans (less two litres) at Kiba, the fuel burn for the DAR/KIBA flight was 38 litres (10.053 gall) in 48 minutes or 0.2094 gallon per minute. This is equivalent to 12.57 gallons per hour.

Working on this rate the fuel burn for the 3.55 hours trip covering KIBA/RUAHA/DAR should be 49.20 gallons. The aircraft had only 46 gallons of usable fuel on take off from Kiba.

1.6.4 More information on 5H-BIG fuel consumption

In the course of the investigation one pilot who had operated 5H-BIG on many flights including the scheduled sectors Dar/Siwandu/Kiba/Ruaha/Dar said that the average endurance of this aircraft (with full tanks) was 0430 hours.

Some observers who frequently witnessed the refuelling of the aircraft at Dar es Salaam prior to Commencement of the Dar/Siwandu/Kiba/Ruaha/Dar schedule said that the aircraft usually carried full tanks as well as four FULL jerry cans for the round trip.

1.7. Meteorological Information

It had been a hot day all along the route of the aircraft with temperatures averaging about 30 degrees Centigrade. Another aircraft 5H-AZN which took off from Ruaha for Dar es Salaam five minutes earlier than 5H-BIG reported a head wind of about 10-15kt all along the route.

1.8. Aids to Navigation

Not applicable

1.9. Communications

The aircraft was in contact with the Dar es Salaam Area Control Centre on 123.3 MHz . At 1259 hours 5H-BIG raised the Dar es Salaam A.C.C. and advised that he was force landing due to fuel starvation. He gave his position as (0703S , 3858E). The Dar A.C.C. subsequently telephoned the operator on the internal Airport telephone extension and reported the occurrence.

1.10 Aerodrome and ground facilities

Not applicable.

1.11 Flight recorders

Not required by regulations None fitted.

1.12. Wreckage information

The aircraft was found parked near a village house on a road side. It had been pushed to this position with the help of the villagers in order to clear the road for normal traffic.

The only damage on the aircraft was a dent on the right wing which was consistent with having struck a small tree during the landing roll.

Two jerry cans each with a capacity of 20 litres were found at the back of aircraft inside the cabin. One was empty and the other contained a small quantity of fuel which was estimated at about 1.5 litres.

The fuel selector was found on the left tank. The fuel cocks on the wing tanks were properly secured. Both tanks were found empty.

The part of the road chosen by the pilot for executing the force landing appeared to have been the best available in the area. The road surface, although unpaved, was in fairly good condition. There was only grass, small trees and cassava plantations on both side of the road. None of these represented potential hazard to the aircraft.

The aircraft made a touchdown in the middle of the road but drifted slightly to the right during the landing roll. As it did so the right wing struck a small tree in front of a roadside house. The tree was knocked down but a person who was sitting down in the shade of the tree survived without injury. The aircraft came to rest on the road after rolling for about 250 metres.

1.13 Medical and pathological information

Not applicable

1.14 Fire

There was no fire

1.15 Survival aspects

This was survivable accident

1.16 Tests and research

The aircraft was initially refuelled with 40 litres of Avgas (20 litres in each tank) at the scene of the accident and the engine was run at various power settings. No fuel leaks were found. After the aircraft had landed at Dar es Salaam both tanks were filled to the brim. No. fuel leaks were found. The aircraft was repaired and it subsequently flew without any problems.

1.17 Other information

1.17.1. The carriage of fuel inside the cabin

The aircraft was carrying two jerry cans of Avgas inside the cabin along with passengers . It was also learnt that the scheduled flights had been carrying fuel in the cabin (four jerry cans) for the DAR/Siwandu/Kiba/Dar flights.

This practice is dangerous. It also contravenes Regulation 40 (4) of the Tanzania Air Navigation Regulations (1983) which forbids the carriage of dangerous goods on board aircraft.

Fuel can only be carried in the cabin with a written permission of the Director General of Civil Aviation in accordance with any conditions to which such permission may be subject.

1.17.2 Gliding

The engine stopped at 1259 hours when the aircraft was 12 minutes (about 19 miles) from Dar es Salaam. The altitude was 11,500 feet which according to the flight manual, should a gliding distance of 17 miles.

In the circumstances Dar es Salaam was outside the aircraft gliding range even in zero wind conditions. Given the 10-15kt head wind prevailing on that day, this gliding distance should have been reduced further.

2. ANALYSIS

Investigations did not establish any fuel leakage which could have contributed to the accident. It was therefore necessary to establish whether the fuel uplift was sufficient to cover the planned flight sector.

Air Navigation Regulations bind pilots flying V.F.R. to take on enough fuel to cover the planned sector as well as a diversion to alternate airfield and 30 minutes hold. In this case the alternate was Zanzibar which was 25 minutes away from Dar es Salaam.

The pilot had calculated his flight time as follows:

DAR - SIWANDU	0:45	hours
SIWANDU - KIBA	0:08	
KIBA - RUAHA	1:35	
RUAHA - DAR	2:20	
	<hr/>	
T O T A L	4:48	hours

Since the flight Manual gave an endurance of more than 6 hours on full tanks the pilot said he was convinced that the full tanks and the extra 10½ gallons carried in the cabin were more than sufficient for the flight.

On a basic average fuel flow rate of 9 gallons per hour the fuel burn should be 43.2 gallons for the 4:48 hours flying time. The usable fuel uplift from Dar es Salaam was 46 gallons (full tanks) and $10\frac{1}{2}$ gallons in jerry cans which should give a total of $56\frac{1}{2}$ gallons. In this case the aircraft should have landed at Dar es Salaam with 13.3 gallons which is equivalent to 1:30 hours at this rate of 9 g.p.h.

The pilot however failed to realise that the fuel consumption rate of 9 g.p.h. was not applicable to this aircraft.

After flying for four-fifth of an hour (48 min) to Kiba he had burnt 38 litres (more than 10 gallons) which he had to replace during the refuelling process. At this moment the pilot should have realised that the actual fuel burn was more than 9 gallons per hour. Infact it was about $12\frac{1}{2}$ gallons per hour. It should thus have been evident that the fuel uplift from Dar es Salaam was insufficient for the round trip.

It has already been calculated in 1.6.4 that the fuel burn was 12.57 gallons per hour. Given that the pilot used BOTH TANKS for the first 10 minutes from KIBA and thereafter selected the RIGHT TANK, the active tank should have lasted at most 1:55 hours; i.e. it should have been exhausted at 10:57 hours or before since the two take-offs and climbouts were also made on this tank.

The fuel selector was found to be serviceable so that it was not possible to explain the pilot's allegation that the RIGHT TANK ran for 2:43 hours while the LEFT TANK lasted only 1:14 hours.

It was also not possible to explain the smell of fuel in the cockpit on landing at Ruaha. However, there was some fuel still left in one of the jerry cans in the cabin which may have leaked in a steep descent. The fuel gauges were also found to be serviceable.

The company Operations Manual lays down the procedure for calculating route fuel requirements. This involves separate calculations for fuel for run up and taxi, enroute fuel, 45 minutes holding at destination, 100n.m diversion and 10% for contingencies. This method of calculating fuel uplift was not used.

The commander was himself a very experienced pilot (more than 10,000 hours) who had spent most of his time flying twins in Mozambique. He had recently returned to Tanzania. However, his recent experience on the Cessna 172 was about 40 hours.

He had once flown to Ruaha on a different Cessna 172, 5H-FUN which had an extra built in fuel tank, capacity 60 litres. This flight covered the sector DAR/RUAHA/DAR only. In the light of what happened to 5H-BIG this cannot be considered adequate for a route proficiency check.

The company itself had no system of recording the fuel remaining at the end of a flight. This meant that the exact figures for aircraft route fuel burn could not be monitored. Had this been done, this particular accident could possibly have been avoided.

It was evident from the calculations that the average fuel burn was more than expected by the pilot. It was infact higher than that given in the manual.

It is normal for an engine to burn more fuel through deterioration in service. However this should not in itself have caused the accident. Infact previous records showed that 5H-BIG was uplifting four jerry cans for the scheduled flight instead of two which were uplifted at Dar es Salaam on the accident flight.

3. CONCLUSIONS

(a) Findings

1. The pilot was properly licenced to undertake the flight
2. The aircraft was properly maintained and its documents were in order.
3. The aircraft was carrying fuel in the cabin.
4. The fuel uplift from Dar es Salaam was insufficient to cover the planned flight sectors.
5. Fuel ran out 19 miles from destination and the aircraft executed a successful force landing on a road.

(b) Cause

The accident was caused by engine failure in flight due to fuel starvation.

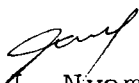
(c) Contributory factors

1. Failure of the company to conduct route check for its pilot before committing him to the scheduled commercial flight.
2. The failure of the pilot to take note of fact that the fuel burn was higher than the figures on which he had based his calculations.

4. SAFETY RECOMMENDATIONS

It is recommended that:

1. The operator should stop with immediate effect the carriage of fuel inside the aircraft cabin unless permitted to do so by the DGCA.
2. The operator should conduct appropriate route checks before pilots are assigned to operate them.
3. The company operations officer should ensure that all the flight planning is made in accordance with procedures laid out in the Company operations Manual.
4. DCA should effect survaillance of operators with the purpose of ensuing that safety rules are adhered to.


J. Nyamwihura
INSPECTOR OF ACCIDENTS.