AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

REVISED REPORT 5 October 2010

Reference	CA18/2/3/8613

Aircraft Registration	ZS-BRU	**Date of Accident**	14 February 2009	**Time of accident**	0730Z
Type of Aircraft	Cessna 182P		**Type of Operation**	Skydiving	
Pilot-in-command Licence Type	Commercial	**Age**	33	**Licence Valid**	Yes
Pilot-in-command Flying Experience	Total Flying Hours	344.5		Hours on Type	30.5
Last point of departure	Cato Ridge Aerodrome, (KwaZulu-Natal province).				
Next point of intended landing	Cato Ridge Aerodrome, (KwaZulu-Natal province).				

Location of the accident site with reference to easily defined geographical points (GPS readings if possible)

Cato Ridge at KwaXimba village, GPS co-ordinates: S 29°40.272´ E 030°37.183´ Elevation 1476 feet AMSL.

Meteorological Information	Surface wind: 030° at 3 knots; Temperature: 27°C; Visibility: +10 km.				
Number of people on board	1 + 6	**No. of people injured**	5	**No. of people killed**	1

Synopsis

The pilot accompanied by five skydivers and one passenger took-off from runway 35 at Cato Ridge aerodrome on a sky diving exercise. Before departing, the aircraft was filled with 105 Litres of Avgas LL 100. Immediately after take-off, during the climb phase, the engine suddenly stopped.

The pilot immediately briefed the passengers and the skydivers were advised to exit the aircraft because the aircraft couldn't maintain height. Two skydivers jumped out and deployed their emergency parachutes and landed safely on the ground. The pilot elected to carry out an emergency landing with the other three skydivers and passenger still on board.

The aircraft impacted the ground on its nose wheel first and the nose strut collapsed. The right-hand wing impacted the ground and the aircraft flipped over. The aircraft was destroyed. One tandem passenger was fatally injured. The pilot, an accelerated free fall student, tandem master and a passenger were seriously injured.

The reason for the engine stoppage could not be determined, but could have been due to fuel starvation.

Probable Cause

Unsuccessful forced landing, following an engine failure in-flight.

Contributory factor/s:

Undetermined engine fuel starvation.

IARC Date		Release Date	

AIRCRAFT INCIDENT REPORT

Name of Owner/Operator	**:** Kwikcorp
Manufacturer	**:** Cessna
Model	**:** 182P
Nationality	**:** South African
Registration Marks	**:** ZS-BRU
Place	**:** Cato Ridge
Date	**:** 14 February 2009
Time	**:** 0730Z

All times given in this report is co-ordinated universal time (UTC) and will be denoted by (Z). South African Standard Time is UTC plus two hours.

Purpose of the Investigation:

In terms of Regulation 12.03.1 of the Civil Aviation Regulations (1997), this report was compiled in the interest of the promotion of aviation safety and the reduction of the risk of aviation accidents or incidents and ***not to establish legal liability****.*

Disclaimer:

This report is given without prejudice to the rights of the CAA, which are reserved.

1. FACTUAL INFORMATION:

1.1 History of Flight:

1.1.1 The pilot accompanied by five skydivers (tandem master, tandem passenger, two skydiving instructors, accelerated freefall student skydiver) and one child passenger , took off from runway 35 at Cato Ridge aerodrome on a skydiving flight with the intention of landing back at Cato Ridge.

1.1.2 According to the pilot, on his arrival at the aerodrome he proceeded with a pre-flight inspection on ZS-BRU in the hanger and the aircraft was later pulled out to the fuel storing unit and was filled with 105 Litres of Avgas LL 100 before departing. According to witnesses, immediately after take-off and during the climb phase at approximately 900ft above ground level (AGL), the pilot informed the skydivers that the aircraft engine had stopped and that they should exit the aircraft.

1.1.3 As the aircraft was descending, two skydivers jumped out of the aircraft at approximately 500 feet above ground level. They immediately deployed their emergency parachutes and landed safely on the ground. The pilot then initiated an emergency landing on an uneven, grass-covered field, approximately 1.6 nautical miles north of Cato Ridge aerodrome at KwaXimba Village.

1.1.4 During landing, the aircraft impacted the ground on the nose wheel first and the nose strut broke, where after the aircraft's right-hand main landing gear and right-hand wing impacted the ground and the aircraft flipped over. The tandem passenger was fatally injured, the pilot, tandem skydiver, student skydiver and the child passenger sustained serious injuries.

1.1.5 The aircraft was destroyed during the accident sequence. The accident happened

during day light conditions at GPS position determined as: S29°40. 272´ E030° 37.183´, elevation 1476 feet AMSL.

Figure 1: An aerial view of where the aircraft took-off from, and the accident site.

1.2 Injuries to Persons:

Injuries	Pilot	Crew	Pass.	Other
Fatal	-	-	1	-
Serious	1	-	3	-
Minor	-	-	-	-
None	-	-	2	-

1.3 Damage to Aircraft:

1.3.1 The aircraft was destroyed during the accident sequence.

Figure 2: View of the wreckage after impact.

1.4 Other Damage:

1.4.1 No other damage was caused.

1.5 Personnel Information:

Nationality	South African	Gender	Male	Age	33
Licence Number	**********	Licence Type	Commercial		
Licence valid	Yes	Type Endorsed	Yes		
Ratings	Instrument and Night Rating				
Medical Expiry Date	30 September 2009				
Restrictions	Nil				
Previous Accidents	None				

Flying Experience:

Total Hours	344.5
Total Past 90 Days	75.9
Total on Type Past 90 Days	30.5
Total on Type	30.5

1.6 Aircraft Information:

1.6.1 Airframe:

Type	Cessna 182P	
Serial Number	182-60977	
Manufacturer	Cessna	
Year of Manufacture	1972	
Total Airframe Hours (At Time of Accident)	8 088.3	
Last MPI (Hours & Date)	8 079.8	30 January 2009
Hours Since Last MPI	8.5	
C of A (Issue Date)	05 August 2008	
C of R (Issue Date) (Present owner)	01 July 2008	
Operating Categories	Standard	
Aerodrome Status	Unlicensed	

1.6.2 Engine:

Type	Continental I0-550-D
Serial Number	833195R
Hours since New	492.8
Hours since Overhaul	Not reached

Note1: The aircraft is powered by a horizontally opposed, six-cylinder, overhead valve injected engine with a wet sump oil system. The engine is a continental IO-550-D and is rated at 300 horsepower at 2 700 revolutions per minute (RPM).

Note 2: The aircraft was fitted with a Continental IO-550-D engine under FAA supplemental type certificate (STC) SA 00152 WI.

When the aircraft was initially manufactured in 1972, the aircraft left the Cessna factory with a carburettor engine. With the installation of the Continental IO-550-D engine under FAA supplemental type certificate (STC) SA 00152, the aircraft was fitted with a more powerful fuel injected engine. This STC also involved the installation of a fuel reservoir, situated above the pilot's rudder pedals, as well as a firewall fuel shut off valve, over and above the standard fuel selector.

1.6.3 Propeller:

Type	Hartzell PHC –L3YF-1RF
Serial Number	FD299A
Hours Since New	2 570.0
Hours Since Overhaul	290.0

Note: The aircraft was equipped with a three-blade, all-metal, constant-speed, governor-regulated propeller.

1.6.4 The aircraft was flown with one door removed.

This type of operation was approved by the FAA and accepted by the SACAA, subject to the following:

Note: This aircraft may be flown with not more than one cabin door removed for the purpose of **Skydiving Parachuting** as approved by the FAA (Federal Aviation Administration) on 05/06/2008.

The following limitations are applicable:

1. Maximum speed not to exceed any of the following:

   a. The approved manoeuvring speed.

   b. 70 percent maximum level flight speed.

   c. 70 percent maximum structural cruising speed.

2. Aerobatic manoeuvres are not permitted.

3. Maximum yaw angle 10 degrees, maximum bank angle 15 degrees.

4. All occupants must wear parachutes when intentional parachute jumping and skydiving operations are conducted.

5. Smoking is not permitted.

6. When operations other than intentional parachute jumping and skydiving are conducted, a suitable guardrail or equivalent safety devise must be provided for the doorway.

7. All loose articles must be tied down or stowed.

8. No baggage may be carried.

9. Parachutist static lines must be kept free of pilot's controls surfaces.

10. Operations are limited to Visual Flight Rules (VFR) conditions.

11. Cabin door hold-open clips installed on wing brace struts and/or under surface of wing must be removed before conducting intentional parachute jumping or skydiving operations.

12. Operations of this aircraft with a door removed for any purpose other than that for which it is certificated is prohibited.

13. Placards must be placed on the instrument panel in full view of the pilot.

14. These operating limitations are a part of the airworthiness certificate.

1.6.5 **Weight and Balance:**

1.6.5.1 Information received from the operator indicated that on takeoff, the seating arrangements in the aircraft, were as per the sketch below:

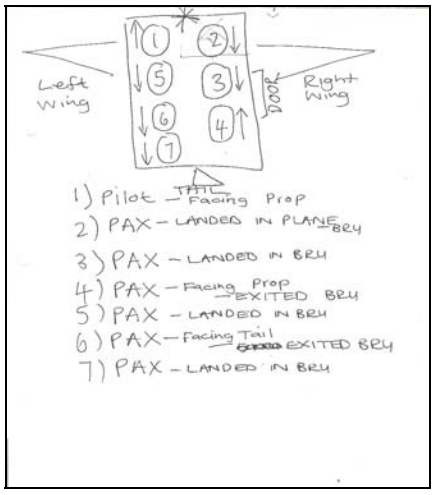


Figure 3: Indicating the seating arrangements on the accident aircraft

1.6.5.2 The aircraft manufacturer was contacted about the weight of the seats as removed from the aircraft as this would have had an impact on the weight and balance calculations of the aircraft prior to take-off.

The aircraft manufacturer stated that the weight of the co-pilot seat was approximately 13 pounds (5.89kg) the second row bench seat weighs approximately 23 pounds (10.43kg).

1.6.5.3 With the assistance of the Parachute Association of South Africa (PASA), the

weights of the skydivers were obtained and the different weights of the equipment used by the skydivers from the manufacturers of the equipment.

The different equipment manufactures stated the following:

Equipment used by the two skydiving instructors and the AFF student.

- *Main parachute-Hurricane 95, Reserve parachute - Decelerator 108, Container - Vortex II - all together weighs 8.5kg.*
- *Main parachute - Hurricane 105, Reserve parachute - Decelerator 120, Container - Vortex II - all together weighs 9.5kg.*
- *Container - Icon 220, Main parachute – there is some confusion about the main parachute used on the day – it may have been a Skymaster 290 or a ZP EXE 235 (considering the weight of the student, it was guessed that it was most likely the Skymaster 290), Reserve parachute - Smart 220 – total weight approximately 13 to 15kg.*

Note: For weight and balance calculation purposes, 14 kg was used.

Equipment used by the Tandem Master and tandem passenger:

- *Strong Dual Hawk System (the container that holds the main and reserve parachutes), A2 360 (the main parachute – 360 denotes the size in square feet), Master 423 (the reserve parachute – 423 denotes the size in square feet) – all together, these weigh 22.7kg.*
- *The passenger harness weighs 4.5kg.*

1.6.5.4 Mass and Balance calculation on take-off:

On Takeoff	Weight(lbs)	X	Arm (Inches)	=	Moment (in.lb)
Airplane(Empty Weight)	1 874		33.81		63359.94
Pilot (**75kg**) *(position 1)*	165		37.0		6105
Tandem master (76.5kg) + parachute (22.7kg) = **(98.3kg)** (position *2*)	217		37.0		8029
Tandem passenger (70kg) + harness (4.5kg) = **(74.5kg)** (position *3*)	164.2		74		12150.8
Instructor 1 (89kg) + parachute (8.5kg) = **(97.5kg)** *(position 4)*	215		97		20855
Instructor 2 (78kg) + parachute (9.5kg) = **(87.5kg)**(position *6*)	193		97		18721
Student (97kg) + parachute (14kg) = **(111kg)** *(position 5)*	245		74		18130
Passenger(Child)(**23kg**)*(position 7)*	51		115		5865
Fuel added to Aircraft (**105 Litres**)	165.9		46.0		7631.4
Ramp Weight	**3290.1**		**48.88**		160847.1
Co-pilot seat	-13		37		-481
2nd row seat	-23		69		-1587
Total Take-off Weight	**3234.75**		**48.77**		**157774**

Note: The Maximum certified total take-off weight for the aircraft type as stipulated in the Pilot Operating Hand Book (POH) is given as **2 950** pounds (1338 kg).

According to the pilot, 105 litres of fuel (Avgas LL100) was added to the aircraft prior departure, but this could not be verified by the investigator, as there was no record of such uplift in the flight folio. The total fuel onboard may have been more than the 105 litres.

Ten litres of fuel was subtracted to account for start and waiting for takeoff. The fuel conversion formula to pounds (lbs), used to compile this report was: 1 Litre of fuel x 1.58.

In this case, the front seat (co-pilot) and the rear seats were removed from the aircraft. As the passengers did not occupy any fixed seats, the centre of gravity (c of g) position could not be determined with any accuracy, but is not considered to have been a factor in the cause of the accident. With two skydivers leaving the aircraft, the aircraft weight would have been reduced accordingly with an associated forward movement of the c of g.

The aircraft's weight at the time the aircraft took-off from the aerodrome was thus calculated to be at least **3234.75**lbs, which was 304.1lbs (137.93kg) **above** the maximum certificated take-off mass.

1.6.5.5 Mass and Balance calculation on impact:

	Weight(lbs)	X	Arm (Inches)	=	Moment (in.lb)
Take-off Weight	**3254.1**		**48.75**		**158664.1**
Fuel for start-up, taxi and run up (**10L**)	-15.8		46.0		-726.8
Instructor 1 (89kg) + parachute (8.5kg) = **(97.5kg)** *(position 4)*	-215		97		-20855
Instructor 2 (78kg) + parachute (9.5kg) = **(87.5kg)**(position *6*)	-193		97		-18721
Weight at time of Accident	**2830.3**		**41.81**		**118361.3**

1.6.5.6 Movement of Centre of Gravity

The aircraft's weight at the time of the accident was calculated to be about **2830.3**lbs, which was 119.7lbs (54.29kg) **below** the maximum certificated take-off mass. The centre of gravity (c of g) was on the limits of the aft c of g as per the POH graph.

However, when the two skydivers exited the aircraft, the c of g moved forward, and towards the centre of the c of g limits.

1.7 Meteorological Information:

1.7.1 The following official weather report was received from the South African Weather Service.

1.7.2 Weather conditions at the time of the accident:

Surface analysis (0600Z 14 February 2009):
A high pressure dominates the central and north-eastern parts of the country, with a low pressure found over KwaZulu-Natal. A trough of low pressure extends from eastern Namibia to the Western and Eastern Cape Provinces. A low-pressure cell exists over the ocean to the south of Durban.

Upper air
A trough of low pressure extends over the southern ocean towards the Western Cape at levels 850, 700, 500 and 250 hPa.

Satellite image:

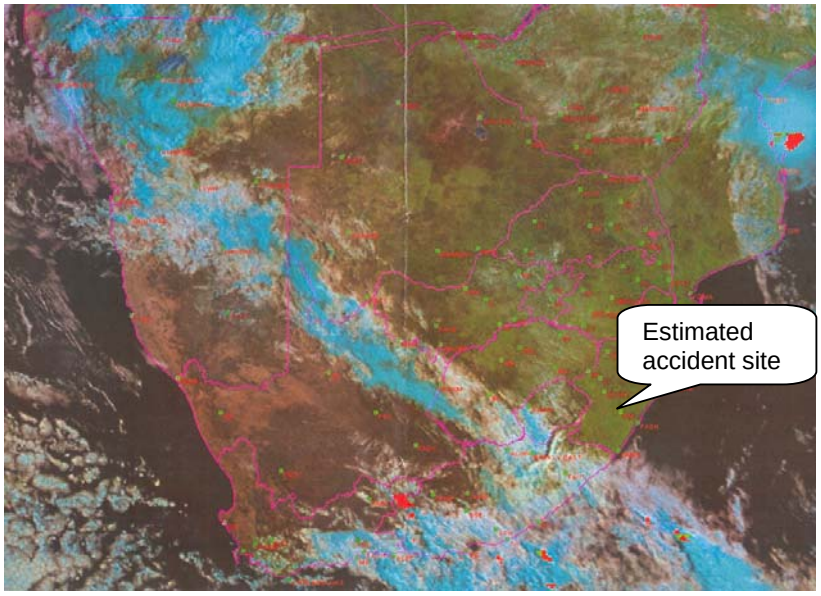


Figure 4: Satellite image of weather conditions at Cato Ridge.

The 0800Z satellite image shows clear skies over KwaZulu-Natal.

1.7.3 Weather conditions in the vicinity of the accident:

Pietermaritsburg reported the following weather at 0700Z:
FAPM 140700Z 03005KT CAVOK 26/17 Q1013=

The most likely weather conditions at the place of the accident were as follows:

Temperature: 27°C
Dew point: 17°C
Surface wind: 030°TN at 3 knots
Cloud cover: No cloud
Visibility: 10 km or more

1.8 Aids to Navigation:

1.8.1 The aircraft was fitted with standard navigation equipment for the aircraft type as approved at the time of certification. The accident occurred shortly after take-off and therefore serviceability of any navigational equipment would have had no bearing as to the cause of the accident.

1.8.2 The aircraft was also fitted with Garmin global positioning system (GPS). The GPS was taken in for analysis but no data could be retrieved from it, as it was not activated for the flight.

1.9 Communication:

1.9.1 There was no communication with air traffic control (ATC) as the aircraft was operated outside of controlled space and the pilot transmitted his intentions on VHF frequency 124.8 MHz.

1.9.2 No difficulties with communication equipment were known or reported prior to the accident. No malfunction of any of the equipment was reported at the time of the accident.

1.10 Aerodrome Information:

1.10.1 The accident did not occur at an aerodrome, but at the geographical position determined as: S29°40. 272´ E030° 37.183´; with an elevation of 1476 feet AMSL.

1.10.2 The Aerodrome information below was the departure aerodrome:

Aerodrome Location	Cato Ridge	
Aerodrome Co-ordinates	S 29°41.40.0' E 030°37.50.3'	
Aerodrome Elevation	2 650 ft	
Runway Designations	1 000 x 15 m	850 x 10 m
Runway Dimensions	17/35	09/27
Runway Used	Runway 35	
Runway Surface	Grass	
Approach Facilities	None	

1.11 Flight Recorders:

1.11.1 The aircraft was not fitted with a Cockpit Voice Recorder (CVR) or a Flight Data Recorder (FDR) and neither was required by regulations to be fitted to this type of aircraft.

1.12 Wreckage and Impact Information:

1.12.1 The aircraft struck the ground in a steep nose-down attitude and flipped over. Both wings and the fuselage showed severe damage. There was no evidence of in-flight structural failure.

1.12.2 The propeller showed signs of the engine operating at a low power setting at the time of impact, with major rearward bending and significant impact damage on two blades and lesser rearward bending on one blade.

1.12.3 The wings and tail section was still attached to the fuselage. The mid-section of the fuselage had split open. The instrument panel was significantly disrupted and offered no information about the pre-impact indications.

1.12.4 The destruction of the cockpit prevented the pre-impact position of the fuel selector and the fuel shut-off valve from being determined.

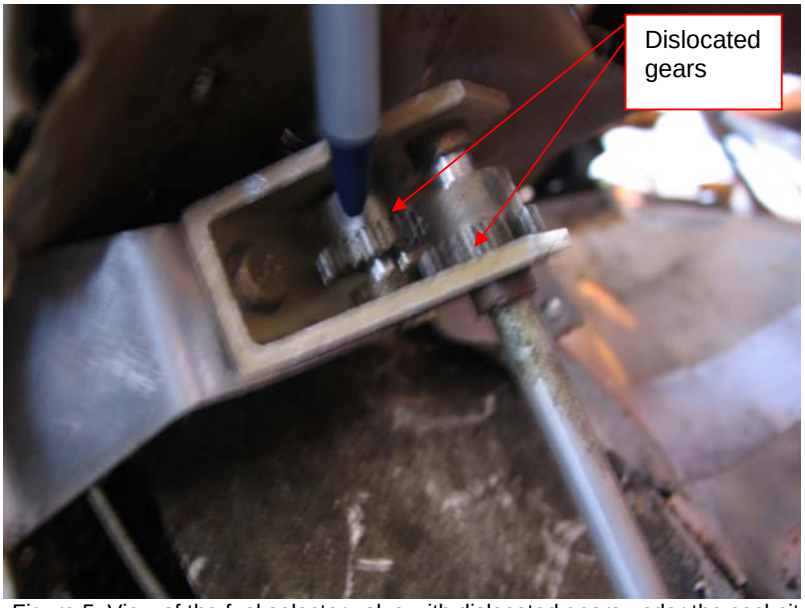


Figure 5: View of the fuel selector valve with dislocated gears under the cockpit floor panel.

Figure 6: First point of impact and final position of the main wreckage.

1.13 Medical and Pathological Information:

1.13.1 The pilot, tandem master, AFF student and passenger sustained serious injuries; they

were all admitted to hospital after the accident.

- The pilot had sustained 4 fractures in his left ankle, ligament damage in his right ankle, his right clavicle (collar bone) was broken and he had a lumbar spine fusion.
- The AFF student sustained serious injuries to his back; he also sustained rib fractures, a punctured lung, and knee and ankle injuries.
- The child/passenger was in a coma, because he sustained brain damage, a broken left femur and collapsed eye that required surgery.
- The tandem master sustained the following serious injuries:

    - Bleeding around the brain
    - Skull fracture above left eye
    - Fractured 9th Rib
    - 3 head, 3 leg, and one arm lacerations requiring stitches
    - Extensive memory loss

1.13.2.1 One tandem passenger sustained fatal injuries. A post-mortem examination was performed on the deceased after the accident. The results of the post-mortem report and toxicology tests were not available at the time that the report was compiled.

1.14 Fire:

1.14.1 There was no evidence of a pre- or post-impact fire.

1.15 Survival Aspects:

1.15.1 The severity of the impact forces resulted in the deformation of the cockpit/cabin area.

1.15.2 The pilot, tandem master, AFF student and passenger were considered very lucky to have survived the accident.

1.15.3 The pilot was properly restrained and secured by a seat belt and safety harness.

1.15.4 The passenger, a minor child who went along for the flight, was not properly restrained in the aircraft. During the investigation it was found that the child was “hooked up” and attached to a strong point in the aircraft with a monkey chain/belt. When the aircraft started experiencing problems, the child was released from the “hooked up” position and was sitting on the lap of the AFF student skydiver, whilst he was sitting on the floor of the aircraft with his back against the back of the pilot’s seat.

It appears that the stipulated limitations, as was granted by the FAA, and which was accepted by the SACAA, was not complied with. Not all the occupants on the aircraft had parachutes whilst the flight was an intentional parachute jumping and skydiving operation.

1.15.5 The tandem master, tandem passenger and AFF student skydiver and child passenger were not restrained on impact.

1.15.6 The two skydivers, who had exited the aircraft after being advised by the pilot to do so, were able to land safely.

1.16 Test and Research:

1.16.1 During the on-site investigation, fuel (AVGAS LL 100) for the reciprocating engine was found in both tanks. The aircraft was refuelled from drums kept at the aerodrome in a shipping container and the possibility existed that the fuel could have been contaminated with water. Fuel samples were taken from both the aircraft's tanks and analysed. No abnormalities were found or identified. The remaining fuel quantity onboard the aircraft could however not be determined nor whether any water was present in the fuel tanks.

Figure 7: Indicating the drum from which the aircraft was refueled and way it was stored..

1.16.2 The engine was removed from the site to an engine overhaul facility at Virginia aerodrome where some selected components were removed and examined under the supervision of SACAA investigators. This included engine components relating to the fuel and oil systems, filters, pumps, ignition system and exhaust.

1.16.3 The following examination was carried out at Virginia aerodrome (Durban) and the following was observed:

- The engine was manually rotated, and compression and valve drain continuity were established for each cylinder.
- Both magnetos and ignition harnesses were tested and were found to be serviceable.
- The spark plugs were removed and examined. The electrodes were intact, and appeared light grey in colour.
- Fuel filter and injectors were removed, inspected and found to be in proper condition and contamination free.
- The carburettor was removed, tested and found serviceable.
- The electric fuel pump was removed, tested and found serviceable.
- Mechanical engine driven fuel pump was removed, inspected and was in good state with gears still intact.

- Examination of the engine revealed no mechanical deficiencies. There was no evidence of any pre-existing electrical or mechanical discrepancy that could have contributed to the accident.

1.16.4 The engine was thereafter assembled and transported to an approved engine overhaul facility at Wonderboom aerodrome, Pretoria, for an engine run on a test cell. Some impact-damaged components (starter motor and a three bladed propeller) were replaced and serviceable ones were fitted.

1.16.5 The engine was replenished with fuel and oil, started and all parameters were met. The engine operated normally, and power was increased in stages until it was evident that it was capable of operating at full power.

1.16.6 The propeller hub was still intact and damage was limited to the propeller blades.

1.16.7 The possibility was investigated that the fuel selector could have been forgotten in the off position by the pilot on take-off or moved inadvertently to the off position, by the tandem skydiver's parachute, as he was sitting on the floor of the aircraft next to the pilot, facing towards the back of the aircraft.

An experienced instructor at Wonderboom aerodrome was therefore requested to conduct a test on a **standard** Cessna 182 aircraft type which was fitted with a different type of engine:

- The aircraft was started, taxied and lined up for take-off. The pilot was cleared for take-off and approximately 60 metres during the take-off roll, the fuel selector was intentionally closed. The aircraft's engine stopped after eight seconds.

With the larger fuel reservoir installed in ZS-BRU, the engine may have operated with a closed valve for a longer period.

1.17 Organisational and Management Information:

1.17.1 This was a flight conducted for Skydiving purposes. There were two drop zone operators at Cato Ridge at the time of the accident.

1.17.2 The last mandatory periodic inspection (MPI) that was carried out on the aircraft, prior to the accident, was certified on 30 January 2009 by an approved aircraft maintenance organisation (AMO).

1.18 Additional information.

1.18.1 In order to understand the skydiving operation and the reason for the number of people onboard the aircraft at the time of the accident, the following information was obtained:

- On board the aircraft were two skydiving instructors and an accelerated free fall (AFF) student.

- According to PASA's Manual of Procedure (MOP) on Accelerated Free Fall (AFF), from levels (1-3) an AFF student must be accompanied by two instructors per jump in order to teach the student to be safe and independent.

- Both the Instructors used their own equipment during the skydiving operation. The AFF student used equipment rented by the skydiving school.

RHS Instructor AFF Student LHS Instructor

Figure 8: Illustration of two skydiving instructors assisting the AFF student

- On board the aircraft was also a tandem master accompanied by a tandem passenger who is hooked up to the tandem master. According to PASA's MOP a Tandem Master is in sole control of a passenger and the tandem parachute equipment.

- PASA's MOP states that when flying in an aircraft with an open door, the passenger shall be seated in front of the Tandem Master, for ease of connection, and of control of the passenger, in the event of an emergency.

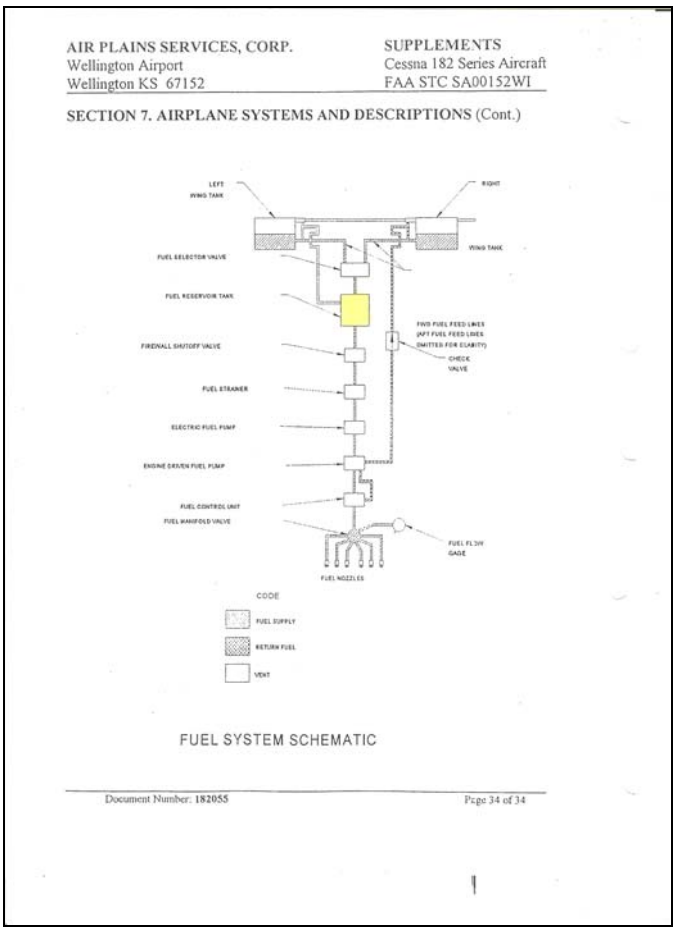
- The sixth person on board the aircraft was the step son of the AFF student who was accompanying the skydiving operation as a passenger.

- These arrangements appear to have been acceptable to the sole pilot.

1.18.2 **Fuel system description:**

Fuel flows by gravity from the wing tanks to a four position selector valve, labelled BOTH, RIGHT, LEFT and OFF. With the fuel selector in the LEFT TANK, RIGHT TANK, or BOTH position fuel flows through a reservoir tank, fuel shut off valve, fuel strainer and (when it is not in operation) through a bypass in the auxiliary fuel pump to an engine driven fuel pump. The engine driven fuel pump delivers the fuel to the fuel control unit where it is metered and directed to a manifold which distributes it to each cylinder. Vapour and excess fuel from the engine driven fuel pump and fuel control unit are returned by way of a vapour return line to the right wing tank.

The fuel reservoir tank which was fitted to the aircraft has a fuel capacity of approximately 3.5 litres.



AIR PLAINS SERVICES, CORP.
Wellington Airport
Wellington KS 67152

SUPPLEMENTS
Cessna 182 Series Aircraft
FAA STC SA00152WI

SECTION 7. AIRPLANE SYSTEMS AND DESCRIPTIONS (Cont.)

FUEL SYSTEM SCHEMATIC

Document Number: 182055 Page 34 of 34

Figure 9: Schematic drawing of the fuel system

1.18.3 The type of restraining mechanism that was used to restrain the child was similar to the images as below:

Figure 10**:** A view/illustration of a "'monkey chain/belt" being secured to the roof structure of an aircraft.

Figure 11**:** A view of a “monkey chain/belt” waste area, plus a safety latch with quick release mechanism.

1.19 Useful or Effective Investigation Techniques:

1.19.1 None.

2. ANALYSIS:

2.1 The pilot, accompanied by five skydivers and one minor child as a passenger, took off from Cato Ridge aerodrome on a skydiving exercise. Immediately after take-off, during the climb phase, at an altitude of approximately 900 ft above ground level, the pilot informed the skydivers that the aircraft engine had stopped. The pilot then advised two of the skydivers to exit the aircraft. The AFF student decided not to jump because he did not want to leave the child alone in the aircraft.

2.2 As the aircraft was descending, two of skydivers successfully jumped out, deployed their emergency parachutes and landed safely. The pilot proceeded in executing an emergency landing, but the aircraft impacted the ground in a steep nose-down attitude and flipped over. Both wings and the fuselage showed severe damage. There was no evidence of in-flight structural failure. The aircraft crashed in an open, grass-covered field, fatally injuring the tandem passenger and seriously injuring the tandem master, AFF student, a passenger and the pilot on board the aircraft.

2.3 The pilot was properly licensed and had a valid medical certificate at the time of the accident.

2.4 It was the pilot’s first flight of the day and the pilot stated that the aircraft engine stopped in-flight.

2.5 The flight was conducted in fine weather conditions.

2.6 During the investigation process, inclusive of various tests and examinations, no anomalies were found or detected on any of the systems including the engine. The aircraft was properly maintained and no documented evidence was found indicating a defect or possible malfunctioning of the aircraft prior to the flight that could have contributed or have caused the accident.

2.7 According to available information no proper weight and balance calculation was done

prior to take-off. Because of that omission, the pilot was unaware of the actual weight of the aircraft at take-off and also unaware that he had exceeded the maximum take-off weight for the aircraft as stipulated in the POH.

2.8 If the maximum weight is exceeded, the aircraft may not be able to achieve or sustain controlled, level flight. Excessive take-off weight may make climbing beyond a certain altitude difficult or impossible, or it may make it impossible to maintain an altitude. When the aft centre of gravity is out of range, the aircraft may pitch uncontrollably up or down, and this tendency may exceed the control authority available to the pilot, causing a loss of control. However prior to the two skydivers exited the aircraft the c of g was on the limits of the aft c of g on the c of g graph and after the two skydivers exited the aircraft the c of g was well within limits.

2.9 Although the aircraft was refuelled from drums kept at the aerodrome in a shipping container protected from the sun and weather, what is of concern was how the drums where stored. This is a potential hazard. If it is necessary to use this type of storage, the drums or cans should be stored off the ground and on their sides. Extraordinary precautions are necessary to eliminate the hazards of water and other contaminants.

2.10 The child passenger onboard the aircraft during this skydiving operation was considered to have been an unsafe practice. This passenger was not restrained as per the requirements as stated in the Civil Aviation Regulations: Part 91.02.08 and Part 91.04.14. Furthermore, after all the skydivers have exited the aircraft, the passenger being a minor would have been left alone, not properly restrained and the pilot flying the aircraft, would not have been in a position to look after the child. It was further considered that the decision to take the child onboard the aircraft was not appropriate. The fact that not all the occupants on the aircraft wore parachutes, as was required by the FAA/SACAA approval, when flying with one door removed, is also considered an unsafe practice.

2.11 In conclusion, no conclusive reason could be established any as to why the engine stopped. Although several possibilities do exist, and one of the possibilities considered, was that at the time full power was taken for take-off, the fuel selector could have been in the OFF position and the firewall shut off valve for the fuel reservoir could have been in the OPEN position. Therefore it could have been that the engine only ran for as long as it would to take to use up the fuel in the reservoir with a resultant engine stoppage. This however cannot be proven due to the destruction of the cockpit, which prevented the pre-impact position of the fuel selector valve and the firewall fuel shut-off valve from being determined.

3. CONCLUSION:

3.1 Findings:

3.1.1 The pilot was a holder of a commercial licence and the aircraft type was endorsed in his logbook.

3.1.2 The pilot's medical was valid at the time of the accident.

3.1.3 The pilot was conducting a skydiving flight.

3.1.4 The operator did not have a record of fuel upliftments for the aircraft.

3.1.5 The last MPI that was certified on the aircraft prior the accident was certified on 30 January 2009.

3.1.6 Fine weather conditions prevailed at the time and were not considered to have contributed to the accident.

3.1.7 No proof was found that 105 litres of Avgas LL100 was in fact uplifted prior departure.

3.1.8 The aircraft was refuelled from drums.

3.1.9 According to the POH (pilot's operating handbook) the aircraft exceeded its allowable maximum take-off weight by at least 304.1lbs (137.93kg), but was about 119.7lbs (54.29kg) below its allowable maximum take-off weight at the time of the accident.

3.1.10 The aircraft was destroyed as a result of the accident.

3.1.11 A concession was granted by the FAA/SACAA that the aircraft may be used for skydiving/ sport parachuting with a door removed.

3.1.12 All occupants on the aircraft did not wear parachutes as required by the concession which was granted by the FAA/SACAA when intentional parachute jumping and skydiving operations are conducted.

3.1.13 The passenger on board the aircraft was not restrained as per the requirements as stated in the Civil Aviation Regulations: Part 91.02.08 and Part 91.04.14.

3.1 Probable cause/s:

3.1.1 Unsuccessful forced landing following an in-flight engine failure.

3.2 Contributing factor/s:

3.2.1 Undetermined engine fuel starvation.

4. SAFETY RECOMMENDATIONS:

4.1 It is recommended that guidelines be developed by RAASA, in consultation with PASA, with regards to the amount of skydivers allowed on board an aircraft.

4.2 It is recommended that RAASA requires PASA to include in their Manual of Procedure information prohibiting passengers accompanying skydivers on a skydiving operation and especially when it comes to minors.

4.2 In order to stop a re-occurrence of this type of accident, it is recommended that the fire wall shut off valve and the fuel selector valve be coupled together so that both valves could only be in the ON or OFF position.

5. APPENDICES

5.1 Appendix A - Civil Aviation Regulations, 1997, Part 91.02.08 and Part 91.04.14.

Report reviewed and amended by the office of the EM:AIID on 5 October 2010

-END-

Appendix A

Part 91.02.08 of the Civil Aviation Regulations, 1997 pertaining to **duties of pilot in command regarding flight operations** requires the following:

(1) The pilot-in-command of an aircraft shall be responsible for–

(a) the operation and safety of the aircraft while he or she is in command;

(b) the conduct and safety of flight crew members and passengers carried; and

(c) the maintenance of discipline by all persons on board;

(2) The pilot-in-command of the aircraft shall have the authority–

(a) to give such commands he or she deems necessary in the interest of the safety of the aircraft, persons or property; and

(b) to disembark any person or cargo which in his or her opinion, represents a potential hazard to the safety of the aircraft, persons or property.

(3) The pilot-in-command of the aircraft shall ensure that all passengers are informed as to–

(a) when and how oxygen equipment is to be used, if the carriage of oxygen is required;

(b) the location and use of life jackets or equivalent individual flotation devices, where the carriage thereof is required;

(c) the location and method of opening emergency exits;

(d) when seat belts are to be fastened;

(e) when smoking is prohibited; and

(f) when portable electronic devices may be used.

(4) The pilot-in-command of an aircraft shall –

(a) ensure that the pre-flight inspection has been carried out, and that the checklists, and where applicable, the flight deck procedures and other instructions regarding the operation of the aircraft, the limitations contained in the aircraft flight manual referred to in regulation 91.03.2, or equivalent certification document, are fully complied with at the appropriate times during a flight;

(b) decide whether or not to accept an aircraft with unserviceabilities allowed by the CDL or MEL, where applicable;

(c) before take-off, ensure that the passengers are briefed on the location and general manner of use of the relevant emergency equipment carried for collective use and, when an emergency arises, shall instruct the passengers to take such emergency action as may be appropriate;

(d) ensure that during take-off and landing and whenever, by reason of turbulence or any emergency occurring during a flight, the precaution is

considered necessary, all persons on board the aircraft are secured in their seats by means of the seat belts or shoulder harnesses provided;

(e) when re-planning, whilst in flight, to proceed along a route or to a destination other than the route or destination originally planned, shall amend the operational flight plan, if such a plan was required in terms of regulation 91.02.7(1)(f);

Part 91.04.14 of the Civil Aviation Regulations, 1997 pertaining to **seats, seat safety belts, harnesses and child restraint devices** requires the following:

(1) No owner or operator of an aircraft shall operate the aircraft unless such aircraft is equipped, as applicable, with –

(a) a seat or berth for each person who is aged two years or more;

(b) a safety belt with or without a diagonal shoulder strap, or a safety harness, for use in each passenger seat for each passenger who is aged two or more;

(c) a restraining belt for use in each passenger berth;

(d) a child restraint device for each passenger who is less than two years of age;

(e) a safety harness for each flight crew member seat, incorporating a device which will automatically restrain the occupant's torso in the event of rapid deceleration; and

(f) a safety harness for each cabin crew member seat:

Provided that a safety belt with one diagonal shoulder strap is permitted if the fitting of a safety harness is not reasonably practical.

(2) Seats for cabin crew members shall, where possible, be located near a floor-level emergency exits, the additional cabin crew member seats required shall be located such that a cabin crew member may best be able to assist passengers in the rearward facing within 15º of the longitudinal axis of the aircraft.

(3) If the pilot-in-command cannot see all the passenger seats in the aircraft from his or her own seat, a means of indicating to all passengers and cabin crew members that seat belts should be fastened, shall be installed.

(4) All safety harnesses and safety belts shall have a single point release.