AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

Reference:	CA18/2/3/9815

Aircraft Registration	**ZS-LMI**	**Date of Accident**	16 August 2019	**Time of Accident**	1700Z
Type of Aircraft	Cessna 172		**Type of Operation**	Training (Part 141)	
Pilot-in-command Licence Type	Commercial Pilot Licence	**Age**	34	Licence Valid	Yes
Pilot-in-command Flying Experience	Total Flying Hours	1514.7		Hours on Type	436.7
Last Point of Departure	Grand Central Aerodrome (FAGC), Gauteng Province				
Next Point of Intended Landing	Grand Central Aerodrome (FAGC), Gauteng Province				

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

On Plot 63 next to the N4 highway at Hartebeesfontein Road at GPS 25°32’59” South 027°55’58” East, at an field elevation of 3862 feet

Meteorological Information	Wind: 150° at 06kt, Temperature: 20°C, Dew point: 0°C, Visibility: 10km and Query nautical height (QNH): 1020hPa				
Number of People On-board	2+0	**No. of people injured**	0	**No. of People Killed**	2

Synopsis

On Friday evening 16 August 2019, at approximately 1630Z, a Cessna 172 aircraft with registration ZS-LMI, took off on a night rating test training flight from the Grand Central Aerodrome (FAGC), with the intention to land back at the same aerodrome. On-board the aircraft were a flight instructor and a private pilot (who was being trained). No flight plan was filed for the flight, nor was it required in terms of Aviation Training Organisation (ATO) procedures. The aircraft had been refueled to capacity prior to the flight. The flight was planned to take approximately 2 hours. No emergency calls were made from the aircraft. The aircraft was reported missing the next morning as it had not returned to FAGC. The Aeronautical Search and Rescue Coordination Centre (ARCC) initiated the search and rescue mission, which located the wreckage on the same morning in an open field, north of Pretoria.

The aircraft was found destroyed; and both pilots had sustained fatal injuries. Post-accident examination of the wreckage did not reveal any faults with the aircraft.

The investigation revealed that it is probable that the pilots lost control while making a left steep turn at low height at night-time from which they were unable to recover, resulting in an impact with the ground.

SRP Date	13 October 2020	Publication Date	15 October 2020

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ABBREVIATION	DESCRIPTION
AAIB	Air Accident Investigation Branch (United Kingdom)
AD	Airworthiness Directive
AIP	Aeronautical Information Publication
AME	Aircraft Maintenance Engineer
AMO	Aircraft Maintenance Organisation
AMSL	Above Mean Sea Level
ARCC	Aeronautical Rescue Coordination Centre
ATO	Aviation Training Organisation
°C	Degrees Celsius
C of A	Certificate of Airworthiness
C of G	Centre of Gravity
C of R	Certificate of Registration
CRS	Certificate of Release to Service
CVR	Cockpit Voice Recorder
FAGC	Grand Central Aerodrome
FDR	Flight Data Recorder
Ft	Feet
FTS	Flight Training School
KIAS	Knots Indicated Air Speed
Kt	Knots
Lt	Litre(s)
M	Metre(s)
MCSA	Mountain Club of South Africa
MPI	Mandatory Periodic Inspection
Nm	Nautical Mile
NTSB	National Transportation Safety Board
ORRU	Off Road Rescue Unit
PF	Pilot Flying
POH	Pilot's Operating Handbook
SACAA	South African Civil Aviation Authority
SA-CAR	South African Civil Aviation Regulations
SA-CATS	South African Civil Aviation Technical and Standards
SAPS	South African Police Service
SASAR	South African Search and Rescue
SAWS	South African Weather Service
SB	Service Bulletin
SD	Spatial Disorientation
SI	Service Instruction
SL	Service Letter
SPS	Superior Pilot Services
TMA	Terminal Manoeuvring Area
USG	US Gallons
UTC	Co-ordinated Universal Time
VFR	Visual Flight Rules
VHF	Very High Frequency

Reference Number	**:** CA18/2/3/9748
Name of Owner/Operator	**:** Lanseria Flight Centre (Pty) Ltd
Manufacturer	**:** Cessna Aircraft Company
Model	**:** Cessna 172M
Nationality	**:** South African
Registration Marks	**:** ZS-LMI
Place	**:** Hartebeesfontein Road, Gauteng
Date	**:** 16 August 2019
Time	**:** 1700Z

All times given in this report are Co-ordinated Universal Time (UTC) and will be denoted by (Z). South African Standard Time is UTC plus 2 hours.

Purpose of the Investigation:

In terms of Regulation 12.03.1 of the Civil Aviation Regulations (CAR) 2011, 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 apportion blame or liability****.*

Investigations process:

The accident was reported to the Accident and Incident Investigations Division (AIID) on 17 August 2019 at about 0630Z. The wreckage was located at 0830Z, 2 hours after it was reported missing. The investigator/s dispatched to the accident site (Hartebeesfontein Road) on 17 August 2019. The investigator/s co-ordinated with all authorities on site by initiating the accident investigation process according to CAR Part 12 and investigation procedures. The South African Search and Rescue (SASAR) handed the accident site to the AIID. The AIID of the South African Civil Aviation Authority (SACAA) is leading the investigation as the Republic of South Africa is the State of Occurrence.

Notes:
1. Whenever the following words are mentioned in this report, they shall mean the following:
1. Accident – this investigated accident
2. Aircraft – the Cessna 172M involved in this accident
3. Investigation – the investigation into the circumstances of this accident
4. Pilot – the pilot/s involved in this accident
5. Report – this accident report

2. Photos and figures used in this report were taken from different sources and may be adjusted from the original for the sole purpose of improving clarity of the report. Modifications to images used in this report are limited to cropping, magnification, file compression; or enhancement of colour, brightness, contrast; or addition of text boxes, arrows or lines.

Disclaimer:

1. FACTUAL INFORMATION

1.1 History of Flight

1.1.1 On Friday evening 16 August 2019, at approximately 1630Z, a Cessna 172 aircraft with registration ZS-LMI, took off on a night rating test training flight from FAGC with the intention to land back at FAGC. On-board the aircraft were a Grade III flight instructor and a private pilot who was being trained. The aircraft was refueled to capacity prior to the flight.

1.1.2 No flight plan was filed for the flight, nor was it required in terms of the operator (Aviation Training Organisation). The aircraft did not make contact with Johannesburg radar; therefore, no squawk code was allocated to the aircraft. It was reported that the aircraft was not visible/tracked on radar. The aircraft also did not appear on the secondary radar (Squawk on 2000) as required by the Aeronautical Information Publication (AIP) 1.6.2. (see Appendix B). The aircraft was reported missing by the operator the next morning as it had not returned to FAGC, and the search and rescue service personnel were alerted thereafter.

1.1.3 According to the reviewed records during the follow-up interview with the operator, the aircraft was refueled to full capacity prior to the flight in which a total of 56 litres was uplifted in both fuel tanks. Flight authorisation records revealed that the aircraft had been refueled three times and had been operated four times prior to the accident flight. A total of 17 aircraft, including ZS-LMI, had refueled from the same aerodrome facility on the day of the accident.

1.1.4 The aircraft took off (1630Z) from FAGC after the aerodrome had closed for the day at 1600Z. The flight was planned to take approximately 2 hours.

1.1.5 According to the Aviation Training Organisation (ATO) Chief Flying Instructor (CFI), he had arrived for work at the aerodrome on 17 August 2019 at 0445Z and had realised that the aircraft had not been signed in as having returned to FAGC (the day before) in the flight authorisation sheet. The CFI then went to the parking bay to verify if the aircraft had returned after he had noted that the instructor and the pilot's belongings were still in the office.

1.1.6 At 0500Z, the CFI confirmed that the aircraft was not at FAGC. There were no records that the aircraft had returned to FAGC the previous day. The CFI then contacted Wonderboom Aerodrome (FAWB) and Lanseria International Aerodrome (FALA) towers to determine whether the ZS-LMI aircraft had landed on either one of the aerodromes. But both FAWB and FALA confirmed that the aircraft did not land at their respective aerodromes.

1.1.7 At 0530Z, the CFI contacted Aeronautical Rescue Coordination Centre (ARCC) to report the missing aircraft; and thereafter, the search and rescue mission was activated. At 0543Z, the fire crew at the aerodrome confirmed that the aircraft departed FAGC at 1630Z the previous day (16 August 2019).

1.1.8 At 0545Z, FAGC management was informed about the missing aircraft; and between 0602Z and 0632Z, FALA tower, FAWB tower and the Accident and Incident Investigations Division (AIID) were also informed about the missing aircraft.

1.1.9 At 0652Z, the aircraft wreckage was located north of the red and white radio mast situated on top of Magaliesberg Mountain. At 0753Z, North West and Gauteng South African Police Service (SAPS), disaster management and patrols were informed of the accident. At 0810Z, ARCC confirmed the location of the wreckage and emergency personnel were dispatched to the site.

1.1.10 One of the witnesses (who was patrolling at Magaliesberg Mountain) reported that he briefly saw a bright light around 1700Z on 16 August 2019. Soon after, he heard a loud bang. He reported that he could not go to the scene to investigate as the area is a crime hotspot. He however, enquired in the community if anyone had heard anything or knew what had caused the loud bang. The witness was positioned at the top of the Magaliesberg Mountain when he witnessed the light. He was facing the direction in which the aircraft had crashed.

1.1.11 Following the accident and during an interview, the CFI of the ATO reported that the night rating training test includes manoeuvres and interception to non-directional beam (NDB), instrument landing system (ILS) and steep turns. The operator further reported that the aircraft was previously flown by two other pilot instructors earlier on 16 August 2020, and they both reported that the aircraft was operating normally. The two pilots confirmed that the aircraft was serviceable throughout their flights and no abnormalities were detected.

1.1.12 The accident occurred at Plot 63 next to the N4 Highway at dusk at a geographical position determined to be 25°32’59” South 27°55’58” East, at a field elevation of 3 862 feet (ft) above mean sea level (AMSL).

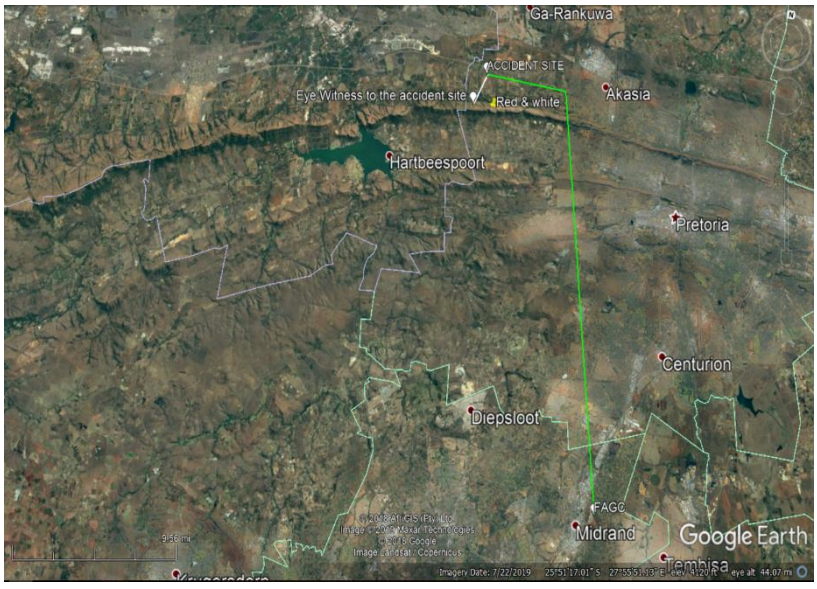


Figure 1: Overlay of the accident site. (Source: Google Earth Maps)

1.2 Injuries to Persons

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

1.3 Damage to Aircraft

1.3.1 The aircraft was destroyed during the accident.

Figure 2: The wreckage of the Cessna 172 at the accident site.

1.4 Other Damage

1.4.1 None.

1.5 Personnel Information

1.5.1 Instructor Pilot

Nationality	South African	Gender	Male	Age	34
Licence Type	0272500000	Commercial Pilot Licence			
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	Tug, instrument rating, instructor grade 3				
Medical Expiry Date	31 August 2019				
Restrictions	None				
Previous Accidents	None				

1.5.1.1 The instructor pilot was issued a medical certificate on 28 August 2018 with an expiry date of 31 August 2019, and with no restrictions.

Instructor Pilot Flying Experience:

Total Hours	1514.7
Total Past 90 Days	38.5
Total on Type Past 90 Days	4.9
Total on Type	436.7

1.5.1.2 The instructor pilot had applied for a Student Pilot Licence (SPL) on 22 July 2014 and it was issued on 12 August 2014. He again applied for the SPL on 31 July 2015 and it was issued on 11 August 2015 with an expiry date of 10 August 2016. The instructor's Commercial Pilot Licence (CPL) was issued on 30 March 2017 with an expiry date of 31 March 2018 and the aircraft type was endorsed on it. The instructor pilot was tested for the night rating on 22 October 2015 and the rating was endorsed on his licence. The instructor pilot did a type conversation on Piper 28A on 27 November 2014.

1.5.1.3 The instructor pilot's logbook was last updated on 19 July 2019 when his Grade II instructor rating was renewed. At the time of the renewal, the instructor pilot had a total of 1514.7 hours,

of which 436.7 were on Cessna 172 as pilot-in-command (PIC). He also flew 1.8 dual hours on Cessna 210 and 15.5 as PIC. The renewal of his type rating was done on 24 March 2019 with an expiry date of 31 March 2020. The renewal of his Grade II instructor rating was done on 19 July 2019 at an approved Aviation Training Organisation (ATO). The pilot was found to be competent on theory and type technical oral test by the ATO. The pilot completed his radio telephony test on 4 November 2014 and on 26 March 2015 during which he was found to be proficient.

1.5.1.3.1 The instructor pilot's last competency check for a Commercial Pilot Licence (CPL) aeroplane was done on 24 March 2019. The pilot was trained as per **61.01.15**(1). *Training for the purpose of acquiring a licence, rating or validation as required by this Part, may only be provided by the holder of an ATO approval issued in terms of Part 141 and under the provisions set out in Document SA-CATS 61.* (See Annexure A)

1.5.1.3.2 According to the information reviewed from the instructor pilot's records, he flew a total of 583 hours as a PIC on multi-engine aircraft.

1.5.1.3.3 There is, therefore, a 28-day period for which no flying history was recorded in the official logbook as called for in Part 61.01.8 of the Civil Aviation Regulations (CAR) 2011.

*NOTE: The instructor pilot had an instrument and night rating endorsed on his pilot licence with a total of 14 hours on his night rating.

Pilot Being Trained

Nationality	Fijian	Gender	Male	Age	27
Licence Type	0275008832	Private Pilot Licence			
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	None				
Medical Expiry Date	22 October 2023				
Restrictions	None				
Previous Accidents	None				

Note: The pilot (who was being trained) was issued a Private Pilot Licence (PPL) on 27 May 2019 with an expiry date of 31 May 2020. The pilot was in possession of a Class 2 medical certificate issued on 22 October 2018 with an expiry date of 22 October 2023, with no restrictions. The aircraft type was endorsed on his licence.

On 4 May 2019, the pilot was recommended by his instructor for his initial PPL skills test. The checklist for PPL completion was only signed by the instructor and the chief flying instructor did not sign the PPL checklist. The pilot successfully completed his initial skills test on 11 May 2019 with a total of 72.5 flying hours of which 52 hours were dual, 15.3 hours were solo, 5.3 hours were dual cross country and 5.0 hours were solo cross country. He also completed an Instrument Flight Simulator with a total of 5.2 flying hours. The total time taken for the briefing was 1.3 hours, the actual flight was 3.1 hours and the debrief time was 0.4 hours. The pilot did his night rating ground evaluation on 16 August 2019, the same day of the accident. The pilot completed his radio telephony proficiency on 27 February 2019.

Flying Experience:

Total Hours	72.5
Total Past 90 Days	38.5
Total on Type Past 90 Days	4.9
Total on Type	4.9

Engineer Experience:

Nationality	South African	Gender	Male	Age	56
Licence Number	0272013798	Licence Type	AME Licence		
Licence valid	Yes	Type Endorsed	Yes		
Ratings	Aeroplanes in group 4 and 6 under CAT A, Aeroplanes in group 4 and 5 under CAT B, Short SCY Skyvans 3 variant 100, Engines in group 1 and 2 under CAT C, Garrett Aire TPE331 Series, Aircraft in Group 4, Engines Group 1,2, P& W PT6A, Series, P & W R986, JACOBS R-755 Series.				

The aircraft maintenance engineer's (AME) licence was initially issued on 14 February 1980. The licence was reissued on 15 August 2018 with an expiry date of 16 September 2020. The AME's licence was valid at the time of the accident.

1.6 Aircraft Information

1.6.1 The ZS-LMI is a Cessna, serial number 172-61100, manufactured in 1973. The aircraft is a light, single-engine, high-wing aeroplane, fitted with a fixed tricycle undercarriage. The aircraft is powered by Lycoming IO-T10-360 engines.

Airframe:

Type	Cessna Aircraft 172M	
Serial Number	172-61100	
Manufacturer	Cessna Aircraft Company	
Date of Manufacture	1973	
Total Airframe Hours (At time of Accident)	3622.60	
Last MPI (Date & Hours)	14 August 2019	3614.1
Hours since Last MPI	8.5	
C of A (Issue and Expiry Date)	3 July 2019	31 July 2020
C of R (Issue Date) (Present owner)	19 February 2003	
Operating Categories	Part 141	
Recommended Fuel Type Used	Avgas LL100	
Previous accidents	According to the airframe logbook, the aircraft veered off the runway during landing in July 2001 and the occurrence was reported to AIID.	

NOTE: The airframe hours of the aircraft at the time of the accident could not be determined with accuracy. They were, however, based on the flight folio, authorisation sheet, last maintenance performed and the estimated flight time leading to the accident which was reported to be approximately 30 minutes. The tachometer or Hobbs meter readings were also not recovered on site due to the destruction of the aircraft during the impact sequence. The hours entered in the table above were obtained from a certified true copy of the aircraft flight folio, which was obtained from the accident site, with the last entry on the last page filled (populated) on the day of the accident dated 16 August 2019. The airframe hours entered were 3622.60.

1.6.2 According to the flight folio and reviewed records, the aircraft last flew on 16 August 2019. According to the aircraft airframe logbook, all Service Bulletins (SBs), Airworthiness Directive (ADs), Service Instructions (SIs) and Service Letters (SLs) applicable at this time were complied with.

Engine 1:

Type	Lycoming O-320-E2D
Model/Part Number	O-320-E2D
Manufacturer Date	Unknown
Serial Number	RL-50671-27A
Hours since New	Unknown
Hours since Overhaul	101.4

Note: The new logbook records as of 22 July 2013: The engine was removed from ZS-FUJ on 22 November 2013 for overhaul. The engine hours at the time are unknown as the old logbooks could not be found. The same engine was then installed on ZS-LMI on 19 March 2019. The engine was installed by the AMO that maintained it. The aircraft was fitted with the following components: magnetos serial numbers 13010413 and 13010615; and carburettor serial number MS806202. Both the total time since new and total time and cycles since new were unknown.

Propeller 1:

Type	McCauley 1C160/CTM7553
Serial Number	P74924
Hours since New	9680.18
Hours since Overhaul	2026.58

Note: The new logbook records as of 16 March 2015: The propeller was removed from the ZS-PZT on 25 April 2014 to be fitted to ZS-LMI. The propeller had a total of 7560 hours total propeller time and recorded 0.0 total time since overhaul. The same propeller was then installed on ZS-LMI on 16 March 2015. The propeller had a total propeller time of 8022.48 hours and total time since overhaul of 461.78 hours. The propeller was then removed on 19 March 2019 for overhaul at a total time of 9587.28 hours total propeller time. It was then installed back on 3 April 2019.

1.7 Meteorological Information

1.7.1 The weather information (below) was provided by the South African Weather Service (SAWS). Surface data and the Meteorological Aeronautical Report (METAR) messages were recorded for FALA, (which is the closest reporting station) at 1800Z and contained the following variables:

Wind direction	South easterly 150°	Wind speed	6 knots	Visibility	10 km
Temperature	20°C	Cloud cover	CAVOK	Cloud base	CAVOK
Dew point	0°C	QNH	1030 hPa		
Moon	None or no full moon reported				

1.7.2 All observational data referred to in this report showed that the weather was not a factor.

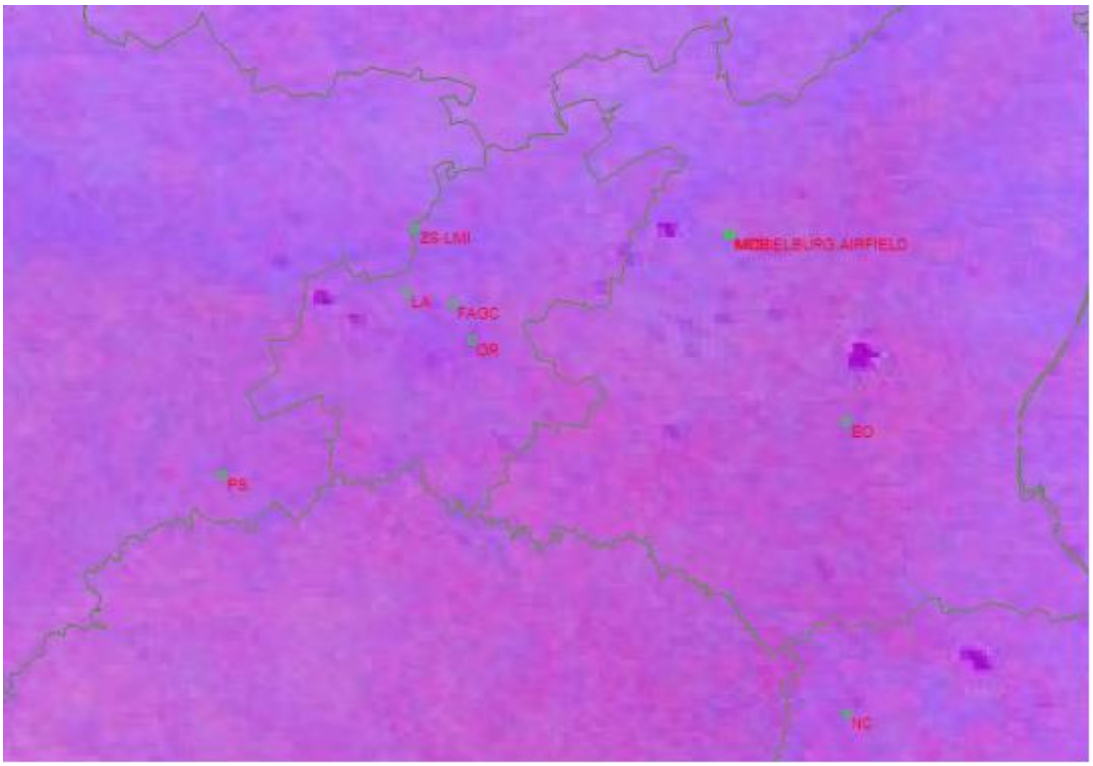


Figure 3: The weather and the position of the wreckage from the departure aerodrome.

1.7.3 Satellite image (Figure 3)

The FOG-A MeteoSat Second Generation (MSG) satellite (above) shows no significant clouds at the time of the accident. The co-ordinates of the Grand Central (departure aerodrome) and wreckage site are plotted on the image. The darker spots on the image indicate significant fires in the area. With no fires in the vicinity of the area where the accident occurred, there is no evidence that visibility was reduced due to smoke from fires at the time of the accident.

1.8 Aids to Navigation

1.8.1 The aircraft was equipped with standard navigational equipment as approved by the Regulator (SACCA). There were no recorded defects with the navigational equipment prior to the flight.

Note: The secondary radar image provided by O.R. Tambo Aerodrome (FAOR) Air Traffic and Navigation Services (ATNS) depicted the flight path of the aircraft minutes before the crash. It was noted that after the aircraft flew past Magaliesberg Mountain ridge line, it proceeded for some distance before executing a right turn, and later crashed. The accident aircraft could not be identified on the secondary radar although other aircraft within the area were clearly identified. According to the pilots who were flying in the area at the time, there were no anomalies or communication with other aircraft at the time and area of the accident.

1.9 Communication

1.9.1 The aircraft was equipped with standard communication equipment as approved by the Regulator. No defects that could render the communication system unserviceable were recorded before the flight. According to the air traffic control (ATC) transcript, ZS-LMI broadcasted blind on frequency 125.0 for take-off clearance.

1.9.2 At the time of the accident, there was no evidence that the accident aircraft was in contact with any other aircraft. There was no squawk code allocated to the aircraft as there was no flight plan filed. As a result, there was no person monitoring the aircraft and no search and rescue was activated when the aircraft did not return to the aerodrome.

2.3 System of SSR Code assignment:

2.3.1 Unless otherwise directed by air traffic control, the last assigned identity (Mode A) code in flight shall be retained. After landing, pilots to ensure that Mode A 2000 is selected. If no identity code is assigned, Mode A 2000 shall be selected and retained.

2.3.2 While operating within South African Airspace, all aircraft shall be equipped and operate a serviceable Mode A and C transponder to prevent occurrences of AIRPROX when;

a) Operating within or transiting any controlled or advisory airspace as listed in paragraph

2.3.3

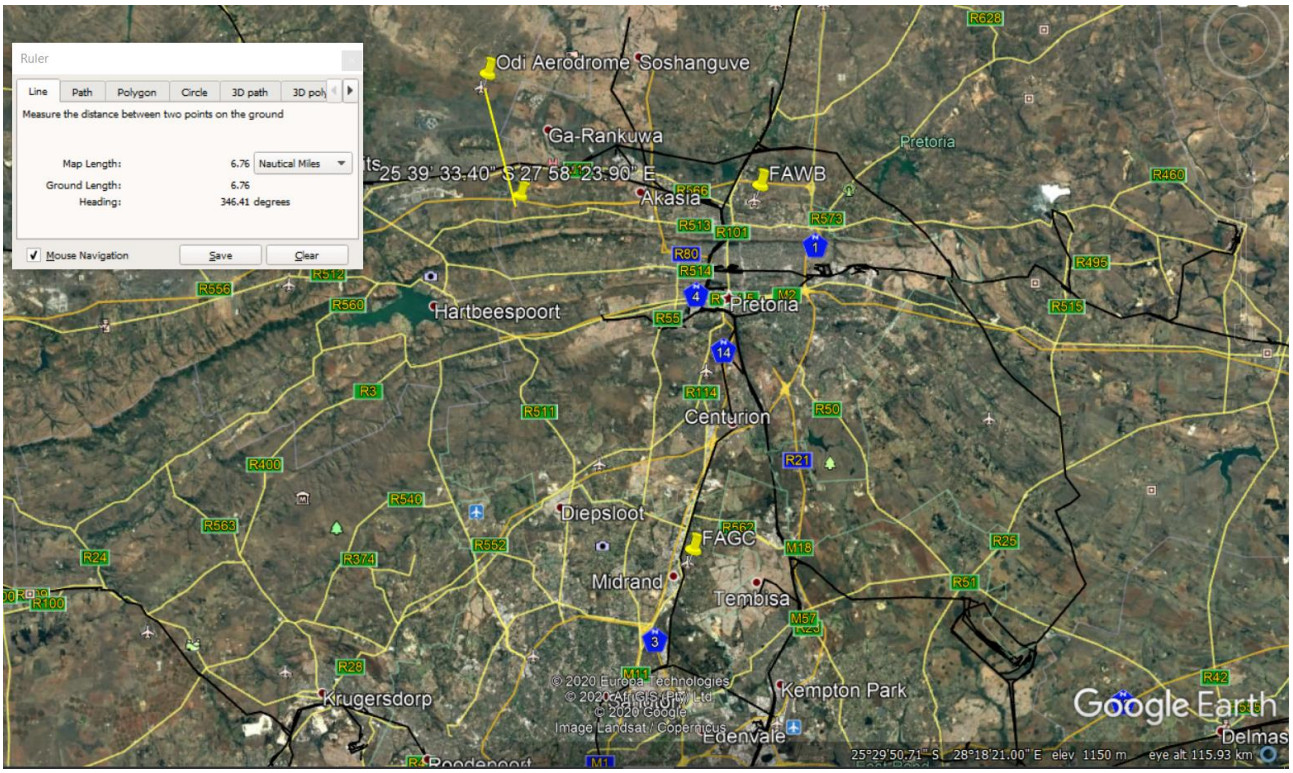
b) Operating within 2000FT above or below such controlled or advisory airspace;

c) Operating below and within 5NM (vicinity) of defined lateral limits of controlled or advisory airspace boundaries;

d) Any other airspace where the operation of transponders have been prescribed by the Director of Civil Aviation

1.10 Aerodrome Information co-ordinates

1.10.1 The accident did not occur at the aerodrome. It occurred north of Pretoria at night at a geographical position determined to be 25°39'33.40" South 27°58'23.90" East at an elevation of 4 271ft AMSL.



1.10.2 The accident occurred during night-time approximately 6.75 nautical miles (nm) north of Odi Aerodrome (FAIO) main entrance, North West province, at Global Positioning System (GPS) co-ordinates determined to be: S25°32'53" E027°56'19" East and at an elevation of 3 862ft.

Aerodrome Location	Odi Garankuwa, North West Province
Aerodrome Co-ordinates	S25°32'53" E027°56'19"
Aerodrome Elevation	3 862 feet
Runway Designations	17/35
Runway Dimensions	2000m x 40m
Runway Used	n/a
Runway Surface	Asphalt
Approach Facilities	None

1.11 Flight Recorders

1.11.1 The aircraft was neither equipped with a flight data recorder (FDR) or a cockpit voice recorder (CVR), nor was it required by regulation for it to be fitted on this aircraft type.

1.12. Wreckage and Impact Information

1.12.1 The aircraft approached from the east heading west at the time of the crash. It impacted a 2.5 metre tree first, and then the ground in a left-wing low and nose down attitude. The examination at the scene showed that the left-wing impacted the ground and the left-wing tip separated; the left-wing tip was found next to the tree. The aircraft then nosed over before coming to rest approximately 19.5 metres (from the first point of impact) before the right wing impacted the stem of the tree, causing the aircraft to disintegrate. The evidence that the propeller separated from the crankshaft flange indicated that the engine was operational at the time of impact (see Figures 6, 7 and 8).

1.12.2 The propeller had separated from the engine during the impact sequence. The crankshaft flange separated as a result of the impact with the ground. The engine and the propeller showed rotational damage (see Figures 6, 7 and 8). The propeller was found approximately 2 to 3 metres in front of the engine (which had separated from the main wreckage). The engine and the propeller were recovered from the accident scene for further examination. The crankshaft flange failure mode was associated with an overload/ductile failure (45° edges around the circumference of the shaft). There was oil spillage from the first point of impact to where the aircraft came to rest.

Figure 4: The aircraft's first point of impact and the position where it came to rest.

Figure 5: The wreckage distribution at the site.

1.12.3 The main wreckage and engine were found 33.2 metres from the first point of impact. There was an 'unfamiliar smell' and oil spillage on the damaged engine.

1.12.4 The left wing was found 38.1 metres from the first point of impact. The roof of the aircraft was found 61.7 metres from the first point of impact. The engine cowl was found 4.2 metres from the wreckage, and the left wing was found 7.9 metres on the left side of the wreckage. The wreckage was spread within an area of 66.2 metres.

1.12.5 All control surfaces, both primary and secondary including the cables, failed from overload during the impact sequence.

1.12.6 There was no fuel smell, however, the wings had ruptured. The grass was dry and there was no evidence of fire.

1.12.7 Wreckage Examination:

1.12.7.1 The wreckage was recovered and transported to the approved aircraft maintenance organisation (AMO) facility at FAWB Aerodrome in Pretoria, Gauteng, for a detailed examination.

1.12.7.2 Flight instrument indications were undetermined due to extensive impact damage. The fuel selector indicator (with right tank fuel selected) was damaged.

1.12.8 The damage to the aircraft was also consistent with the left-wing low attitude before impact with the ground. Flight control continuity of the elevator and rudder system was established.

1.12.9 The nature of the damage to the propeller and engine where it failed or separated (sign of discolouration on the failed area) indicated that the engine was turning at the time of impact with the ground. Therefore, it eliminated the possibility of engine failure prior to the accident.

Figure 6: Close view of the propeller that detached from the crankshaft flange.

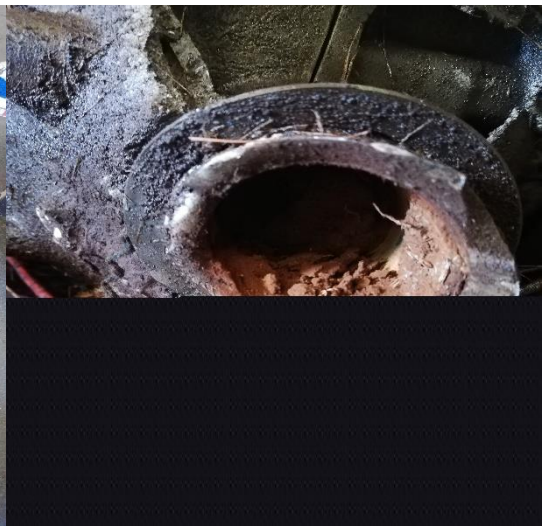


Figure 7: The propeller that detached from the crankshaft flange. **Figure 8:** The fractured surface of the crankshaft flange.

1.12.10 A visual examination of the engine and its accessories revealed no anomalies. The engine throttle or power lever was in a fully forward position, which was an indication that it was producing power at the time of impact. No anomalies that may have hindered engine operation were found.

1.12.11 All aircraft mechanical components found were examined, and none showed signs that a mechanical failure might have contributed to the accident.

1.13 Medical and Pathological Information

1.13.1 The pilots' medical records reviewed from the SACAA showed that they had no medical conditions that could have contributed to the accident.

1.13.2 Both pilots' post-mortem reports were not available at the time of finalising this report. Should any of the results have a bearing on the circumstances leading to the accident, they will be treated as new evidence and that will necessitate the reopening of the investigation.

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 accident was considered not survivable as the cockpit structure was destroyed on impact. Both occupants made use of the aircraft safety harnesses which had failed during impact. Both occupants were thrown out of the wreckage during the accident sequence.

1.16 Tests and Research

1.16.1 Both fuel tanks had ruptured during the accident sequence. The investigation could not determine the total capacity of fuel that was on-board the aircraft. The investigation team engaged the fuel facility operator at FAGC to establish if fuel was of the right quality and grade. The fuel used was from bulk fuel that was stored at FAGC. The operator (aerodrome) takes fuel samples for inspection every morning. The fuel was consistent with AVGAS 100LL and was free from contamination. The test results revealed that fuel was good and clean. Seventeen aircraft, including the ZS-LMI, were refuelled on the same day of the accident from the same tank. No anomalies were reported. Oil and water methanol samples were examined and found to be within specifications and without contamination.

1.16.2 Engine examination

1.16.2.1 The engine, a Lycoming O-320-E2D serial number RL-50671-27A, was recovered from the accident site and was transported to an approved engine maintenance facility for further inspection and examination. Engine teardown was not conducted. The damaged propeller blade and the propeller assembly separation from the flange indicated that the engine was turning at the point of impact (see Figures 6, 7 and 8).

1.17 Organisational and Management Information

1.17.1 The flight was a night rating test training. The ATO was in possession of an approved ATO certificate issued on 7 July 2017 with an expiry date of 30 June 2022. The operator was also in possession of an approved operations manual. The new ATO certificate with a new ATO number was issued on 13 August 2019. The aircraft type was endorsed on it and the training type, which is night rating, was also endorsed on it.

1.17.2 The AMO that maintained the aircraft was certificated and was approved to maintain the aircraft type. The last audit was conducted on 5 February 2019 and there were no recorded findings that would have contributed to the accident. The AMO was in possession of an approved AMO certificate issued on 8 March 2019 with an expiry date of 1 March 2020. The AMO was approved for the following category ratings: A, B and C. The engineer who signed out the Mandatory Periodic Inspection (MPI) in the logbook was equipped and authorised to release the aircraft. Following the renewal audit, the AMO management submitted an application for an amendment to include a new quality and safety manager. The amendment audit was conducted on 5 February 2019. The operational specification was amended to reflect the updated amendment.

1.17.3 The FAGC was issued an aerodrome operating certificate on 31 July 2019 with an expiry date of 31 July 2022. The certificate was valid for a period of 36 months and issued pursuant to the provisions of Part 139 of the Civil Aviation Regulations 2011 as amended. The aerodrome was approved to operate under Category 3 and was approved for the following services: Rescue and Fire Services CAT 3; Navigation Aids: VOR - Nil, NDB - 1, OLS - Nil, Radar - Nil, ATC - available until 1600Z, Runway Lighting – PAPIs on Runway 17/35, Lighting on Runway 17/35 and Emergency Power Generators - Yes.

1.17.4 The ATO was issued an Air Operating Certificate on 28 February 2017 with an expiry date of 30 June 2022. The certificate was valid for five years and issued pursuant to the provisions of Part 141 of the Civil Aviation Regulations 2011 as amended. The following was approved as specific courses for the operator: PPL (61), Type Rating, Night Rating (61), CPL (61), Instructors Rating (61) Sim Training (61), ATP (61), Instrument Rating (61), Exam Centre (61), Class rating, Turbo Prop/jet rating (61) and radio telephony.

1.18 Additional Information

1.18.1 None.

1.19 Useful or Effective Investigation Techniques

1.19.1 None.

2. ANALYSIS

2.1 General

From the available evidence, the following analysis was made with respect to this accident. These shall not be read as apportioning blame or liability to any particular organisation or individual.

2.2 Man

2.2.1 The flight instructor was properly licensed for the flight. He was issued a Commercial Pilot Licence (CPL) on 24 March 2019 with an expiry date of 31 March 2020, and the aircraft type was endorsed on his licence. The flight instructor was issued a medical certificate on 28 August 2018 with an expiry date of 31 August 2019, and with no restrictions.

2.2.2 The pilot (who was being trained) was issued a Private Pilot Licence (PPL) on 27 May 2019 with an expiry date of 31 May 2020. The pilot was in possession of a Class 2 medical certificate issued on 22 October 2018 with an expiry date of 22 October 2023, with no restrictions. The aircraft type was endorsed on his licence. The pilot successfully completed his initial skills test on 11 May 2019.

2.2.3 The instructor pilot was experienced with many night flight hours and had been constantly flying in the years prior to the accident day. He also had experience in night flight or instrument flight and had only been endorsed on this aircraft type after the renewal or validation of his licence. The pilot (who was being trained) had enough knowledge of the aircraft, and emergency procedures were found to be adequate due to the experience reflected on the reviewed and analysed personal qualifications and had received adequate briefing prior to the flight.

2.2.4 The investigation revealed that it was probable that the pilots lost control while making a left steep turn at night-time at low height from which they were unable to recover, resulting in an impact with the ground.

2.3 Machine

2.3.1 The aircraft was issued a certificate of airworthiness (C of A) on 3 July 2019 with an expiry date of 31 July 2020. The aircraft was last serviced at 3614.1 hours on 14 August 2019. The certificate of registration (C of R) for the present owner was issued on 19 February 2003. The last flight folio entry was made on 16 August 2019 at 3622.6 airframe hours. The aircraft hours since its last inspection are unknown due to the instruments being damaged.

2.3.2 Examination of the maintenance documentation found no evidence of pre-existing failures that might have contributed to the accident. The propeller indicated that the aircraft had power and it impacted the ground at a high speed. The damaged propeller assembly separation from the flange occurred in torsional overload failure. The blades showed evidence of torsional damage. This type of torsional (rotational) damage occurs when an engine strikes the ground in a relatively steep angle (mostly vertical strike component) and, thus, the typical curling of the blades that occurs when the propeller has a horizontal strike component during the impact sequence. Therefore, this damage would be the most prominent evidence showing that the engine was producing power at the time of impact.

2.4 Environment

2.4.1 The flight was conducted under night visual flight rules (VFR) and fine weather conditions prevailed at the time of the accident: Wind: 150° at 06kt, Temperature: 20°C, Dew point: 0°C, Visibility: 10km and Query nautical height (QNH): 1020hPa; therefore, the weather was not a factor in this accident. Flight in night VFR involves deriving orientation information from the aircraft's instruments.

2.4.2 Based on the fact that the aircraft, operating under night VFR, was being flown at night at low altitude in a mountainous area and that the pilots were executing steep turns, there was little (insufficient) lighting in this area to provide any consistent visual reference. There was no evidence of a pre-existing defect in the aircraft that may have contributed to the occurrence, nor was there any evidence of a medical condition that could have affected both pilots' ability to control the aircraft. The investigation revealed that it was probable that the pilots lost control while making a left steep turn at night-time at low height from which they were unable to recover, resulting in an impact with the ground.

2.4.3 Lack of flight following by operator.

3. CONCLUSION

3.1 General

From the available evidence, the following findings, causes and contributing factors were made with respect to this accident. These shall not be read as apportioning blame or liability to any particular organisation or individual.

To serve the objective of this investigation, the following sections are included in the conclusions heading:

1. **Findings –** are statements of all significant conditions, events or circumstances in this accident. The findings are significant steps in this accident sequence, but they are not always causal or indicate deficiencies.

2. **Causes –** are actions, omissions, events, conditions, or a combination thereof, which led to this accident.

3. **Contributing factors –** are actions, omissions, events, conditions, or a combination thereof, which, if eliminated, avoided or absent, would have reduced the probability of the accident or incident occurring, or mitigated the severity of the consequences of the accident or incident. The identification of contributing factors does not imply the assignment of fault or the determination of administrative, civil or criminal liability.

3.2 Findings

3.2.1 The instructor was issued a Commercial Pilot Licence (CPL) on 24 March 2019 with an expiry date of 31 March 2020. The renewal of his Grade II instructor rating was done on 19 July 2019 at an approved Aviation Training Organisation (ATO). The renewal of his type rating was done on 24 March 2019 with an expiry date of 31 March 2020. The pilot was found to be competent on theory and type technical oral test by the ATO. The pilot was in possession of a valid aviation medical certificate issued on 28 August 2018 with an expiry date of 31 August 2019, and with no restrictions.

3.2.2 The pilot (who was being trained) was issued a Private Pilot Licence (PPL) on 27 May 2019 with an expiry date of 31 May 2020. The pilot was in possession of a Class 2 medical certificate issued on 22 October 2018 with an expiry date of 22 October 2023, with no restrictions. The aircraft type was endorsed on his licence. The pilot successfully completed his initial skills test on 11 May 2019.

3.2.3 The instructor pilot and the pilot being trained had enough knowledge on the aircraft, and their emergency procedures were found to be adequate due to the experience reflected on the reviewed and analysed personal qualifications.

3.2.4 The last annual inspection was carried out on 14 August 2019 at 3614.1 airframe hours. The aircraft only accrued 8.5 hours since its last maintenance. This was a training (night rating

test) flight. The aircraft flew a total of 4.3 hours with different instructors on the day of the accident. There were no reported anomalies according to the reviewed documents.

3.2.5 The engine Lycoming O-320-E2D SN: RL-50671-27A had no history since new. The engine was overhauled on 30 September 2018 at 5369.6 hours by an AMO. At the time of the accident, the engine had accumulated 101.4 hours since overhaul.

3.2.6 The propellers were overhauled on 23 October 2018 at 9680.18 hours. At the time of the accident, the propellers had accumulated 9595.78 hours since overhaul.

3.2.7 The aircraft was issued a C of A on 3 July 2019 with an expiry date of 31 July 2020.

3.2.8 The aircraft was issued a certificate of release to service on 2 August 2019.

3.2.9 The aircraft was issued a certificate of registration on 19 February 2003.

3.2.10 The aircraft last flew a total of four flights on 16 August 2019 before the accident flight. The Certificate of Release to Service for this aircraft was issued on 2 August 2019 at 13569.20 (Hobbs 3570.40) airframe hours and with an expiry date of 1 August 2020 or at 13619.20 (Hobbs 3620.40) airframe hours, whichever occurs first.

3.2.11 The propeller blades had separated from the hub. The engine teardown was deemed not necessary as the flange and propeller damage showed signs of rotational impact. The engines were examined externally by the investigation team and the engine damage was a result of post-impact.

3.2.12 Both fuel tanks ruptured during the accident sequence and there were no indications of fuel spillage on site as the investigators only arrived at the site the following day after SASAR located the wreckage.

3.2.13 The engine's total hours since new are unknown and the AMO did not have the total hours during the investigation. The hours since overhaul were, however, recorded. At the time of the accident, the engine had accumulated 1702.6 hours since its last overhaul. This is the record reflected in the aircraft's new logbook. The old logbooks could not be provided.

3.2.14 The propeller blades total hours since new are unknown and the AMO did not have the total hours during the investigation. The hours since overhaul were, however, recorded. At the time of the accident, the engine accumulated 1702.6 hours since its last overhaul. This is the record reflected in the aircraft's new logbook.

3.2.15 The aircraft was equipped with instrumentation and certified for both IFR and VFR flights. The aircraft was destroyed during the impact sequence and the engine was found to have been damaged due to the impact sequence. The propeller hub had separated from the crankshaft flange. The fractured part showed that the engine had power. It was evident from

these fractured pieces that the engine was delivering power when the aircraft impacted the ground.

3.2.16 The flight was conducted under night VFR and fine weather conditions prevailed at the time of the accident: Wind: 150° at 06kt, Temperature: 20°C, Dew point: 0°C, Visibility: 10km and Query nautical height (QNH): 1020hPa, therefore, the weather was not a factor in this accident.

3.2.17 Due to the extent of the damage on the aircraft, it was not possible to account for all the components or structures of the aircraft on site. The wreckage was reconstructed at the hangar following its recovery from the accident site. The right-side wing strut of the aircraft could not be accounted for.

3.2.18 The investigation revealed that it is probable that the pilots lost control while making a left steep turn at night-time at low height from which they were unable to recover, resulting in an impact with the ground.

3.3 Probable Cause/s

3.3.1 The pilots might have lost control while making a left steep turn at night-time at low height from which they were unable to recover, resulting in an impact with the ground.

3.3.2 Contributory Factors:

3.3.2.1 None.

4. SAFETY RECOMMENDATIONS

General

The safety recommendations listed in this Report are proposed according to paragraph 6.8 of Annex 13 to the Convention on International Civil Aviation and are based on the conclusions listed in heading 3 of this Report; the AIID expects that all safety issues identified by the investigation are addressed by the receiving States and organisations.

4.1 Safety Recommendation/s

4.1.1 Safety message: Following the accident, the operator had implemented a procedure to have a chief flying instructor to monitor aircraft that fly outside of the operating hours of the aerodrome's air traffic control working hours.

5. APPENDICES

5.1 Appendix A - Part 61.01.15 of 2011as amended- Training for acquiring licence, rating or validation.

5.2 Appendix B AIP 1.6.2

This Report is issued by:

Accident and Incident Investigations Division

South African Civil Aviation Authority

Republic of South Africa

Appendix A

Training for acquiring licence, rating or validation 61.01.15

(1) Training for the purpose of acquiring a licence, rating or validation as required by this Part, may only be provided by the holder of an ATO approval issued in terms of Part 141 and under the provisions set out in Document SA-CATS 61.

(2) For training towards the issue of a pilot licence to be recognised as integrated training, such training must be conducted in accordance with an approved training course, meeting the conditions, requirements, rules, procedures and standards as prescribed in Appendix 3.0 to Document SA-CATS 61 – CPL/IR (A)/ATPL (A) Integrated Course.

Privileges and limitations of SPL 61.02.5

(1) The holder of a valid SPL may only fly solo as prescribed in Document SA-CATS 61 for the purpose of training for the applicable pilot licence –

(a) in the type of aircraft in which he or she is undergoing training as endorsed in his or her logbook;

(b) after a prior written authorisation thereto for a flight, or a sequence of flights, as prescribed in the relevant curriculum and all such flights are under the supervision of the holder of an appropriate and valid flight instructor rating, or a person appointed by the Chief Flying Instructor, provided that such person is the holder of at least a PPL.

(c) without carrying any passengers;

(d) on a flight other than an international flight; and

(e) in VMC by day.

(2) Notwithstanding the provision of sub-regulation (1)(e), a student undergoing the integrated training may exercise the privileges of his or her SPL also –

(a) in VMC by night, if he or she is the holder of a valid night rating; and

(b) under IFR, if he or she is the holder of a valid instrument rating.

(3) Except in an emergency, a student pilot may not land or take-off in an aeroplane from an area other than an aerodrome.

(4) If a student pilot has executed an emergency landing with an aeroplane in an area other than an aerodrome, only the holder of a CPL or ATPL, or another pilot approved for the purpose in writing by the Director, may fly that aeroplane out of that area.

Appendix 3.0

SA CATS FCL 61

This document is based on Appendix 1 to JAR–FCL 1.160 & 1.165(a)(1) ATPL (A) integrated course.

Syllabus for the CPL (VFR) CPL (IR) ATPL Aeroplane Integrated Training Course (TS 61.01.22)

1 Introduction

1.1 The objective of the ATPL (A) integrated training course is to –

(a) provide the theory training required for the ATPL examinations, which, once passed, shall remain valid in accordance with the provisions of TS 61.01.14;

(b) to obtain the CPL (A)/IR and obtain credit for all the theoretical knowledge requirements of the ATPL (A);

(c) provide the practical training required to obtain a CPL and IR; and

(d) qualify the trainee pilot with the necessary MCC skills required to operate as a co-pilot on multi-pilot, multi-engine aeroplanes used in commercial air transportation operations.

1.2 This course is designed to ensure continuous learning in a carefully supervised and authorised Part 141 Aviation Training Organisation. As a result of the integrated learning, together with a high standard of instruction and high-quality training equipment, this course, which is approved by the Commissioner, allows for less flight training than the traditional modular approach.

1.3 The Part 141 Aviation Training Organisation shall ensure that before being admitted to the course the applicant has sufficient knowledge of Mathematics, Physics and English, to facilitate an understanding of the theoretical knowledge instruction content of the course. The required level of English shall be in accordance with CATS 61.01.11.

1.4 An applicant wishing to undertake an approved ATPL (A) integrated course shall, under the supervision of a Part 141 Aviation Training Organisation complete all the instructional stages in one continuous approved course of training as agreed with the Commissioner and arranged by the organisation.

1.5 The duration of the course shall normally be between 12 and 36 months. Under exceptional circumstances and upon written application to the Commissioner, approval may be granted to extend the course beyond 36 months provided that additional flying training or ground instruction is provided by the Part 141 Aviation Training Organisation.

1.6 An applicant may be admitted to training either as an *ab-initio* entrant, or as a holder of a PPL (A) or PPL (H) issued in accordance with ICAO Annex 1. An *ab-initio* entrant shall meet the student pilot requirements of Regulation 61.02. In the case of a PPL (A) or PPL (H) entrant, 50% of the aircraft hours flown by the entrant prior to the course may be credited towards the required flight time, as detailed in paragraph 4 of this document. The maximum credit shall be of 40 hours flying experience or 45 hours if an aeroplane night flying qualification has been obtained. Not more than 20 hours of which dual instruction may be credited. The credit for the hours flown shall be at the discretion of the Part 141 ATO and entered into the applicant's training record.

1.7 In the case where an applicant fails to or is unable to complete the entire integrated ATPL (A) course then he or she may, subject to the provisions of TS 61.01.14 and any other requirements stipulated by the Commissioner be credited with all or a part of the theoretical knowledge examination papers successfully completed.

1.8 Any applicant wishing to transfer to another Part 141 Aviation Training Organisation during a course of integrated training shall apply in writing to the Commissioner for an assessment of the further hours of training required at another Part 141 Aviation Training Organisation.

1.9 The Part 141 Aviation Training Organisation shall ensure that, before being admitted to the course, the applicant has sufficient knowledge of Mathematics, Physical Science and English, to facilitate an understanding of the theoretical knowledge instruction content of the course. The required levels are:

(a) In respect of Mathematics and Physical Science (or Physics) – NQF Level 4; and

(b) in respect of English – in accordance with CATS 61.01.11.

Appendix B:

From AIP 1.6.2-

2.3 System of SSR Code assignment

2.3.1 Unless otherwise directed by air traffic control, the last assigned identity (Mode A) code in flight shall be retained. After landing pilots to ensure that Mode A 2000 is selected. If no identity code is assigned, Mode A 2000 shall be selected and retained.

2.3.2 While operating within South African Airspace all aircraft shall be equipped and operate a serviceable Mode A and C transponder to prevent occurrences of AIRPROX when;

a) Operating within or transiting any controlled or advisory airspace as listed in paragraph 2.3.3

b) Operating within 2000FT above or below such controlled or advisory airspace;

c) Operating below and within 5NM (vicinity) of defined lateral limits of controlled or advisory airspace boundaries;

d) Any other airspace where the operation of transponders have been prescribed by the Director of Civil Aviation

e) Recreational microlights, gliders, paragliders and hang gliders operating in the vicinity of any controlled airspace shall remain clear of all controlled airspace boundaries, while maintaining full radio communication and are exempt from clauses b and c of paragraph 2.3.2 until the entire paragraph 2.3.2 has been revised.

2.3.3 An example of radiotelephony phraseology to be used by ATC on transferring aircraft at a FIR boundary - ZSMDC SQUAWK ALFA 2000 Contact Johannesburg Area on FREQ 120,300 MHz. Scheduled and non-scheduled IFR traffic will be allocated different discreet codes by ATC

to avoid confusion, on the radio.

Note 1:

Only Bram Fischer (FABL), Cape Town (FACT), George (FAGG), O R Tambo (FAOR), King Shaka (FALE), Port Elizabeth (FAPE) and East London (FAEL) is presently equipped with SSR. Advice on further centres will be made available when they are suitably equipped.