AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

			Reference:			CA18/2/3/9990	
Aircraft Registration	**ZS-PXI & ZS-OMN**	**Date of Accident**	26 April 2021		**Time of Accident**	1711Z	
Type of Aircraft	Cessna 172M (Both Aircraft)		**Type of Operation**		Training Flights (Part 141)		
Pilot-in-command Licence Type (ZS-PXI)	Commercial Pilot Licence		**Age**	24	**Licence Valid**	Yes	
Pilot-in-command Flying Experience (ZS-PXI)	**Total Flying Hours**		685.2		**Hours on Type**	412.7	
Pilot-in-command Licence Type (ZS-OMN)	Commercial Pilot Licence		**Age**	31	**Licence Valid**	Yes	
Pilot-in-command Flying Experience (ZS-OMN)	**Total Flying Hours**		1 902.5		**Hours on Type**	1 022.9	

Last Point of Departure (ZS-PXI)	Lanseria International Aerodrome (FALA), Gauteng Province
Next Point of Intended Landing	Lanseria International Aerodrome (FALA), Gauteng Province
Last Point of Departure (ZS-OMN)	Rand Aerodrome (FAGM), Gauteng Province
Next Point of Intended Landing	Rand Aerodrome (FAGM), Gauteng Province
Damage to Aircraft	Both Destroyed

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

Near the Golf Alpha Victor (GAV) beacon at GPS co-ordinates: 26°29'44.05" South 027°43'00.30" East, at an elevation of 5 082 feet

Meteorological Information	Surface wind: 270º/03 kts; temperature: 19ºC; dew point: 0ºC; Visibility: CAVOK; QNH: 1021hPa						
Number of People On-board	2+0 and 2+0	**Number of People Injured**	0	**Number of People Killed**	4	**Other (On Ground)**	0

Synopsis

On Monday evening, 26 April 2021 at 1711Z, a Cessna 172M aircraft with registration ZS-PXI and a Cessna 172M aircraft with registration ZS-OMN were destroyed during a mid-air collision accident that occurred near the Golf Alpha Victor (GAV) beacon in Gauteng province. At the time of the accident, visual meteorological conditions (VMC) prevailed by night. A flight plan was filed for the ZS-PXI aircraft which took off from Lanseria International Aerodrome (FALA) in Gauteng Province. No flight plan was filed for the ZS-OMN aircraft as it was a local training flight in the Johannesburg flying training area (FAD 182). The ZS-PXI aircraft was conducting Exercise 18A (night navigation exercise) and the ZS-OMN aircraft was conducting Exercise 19 (night instrument rating). Both flights were conducted under the provisions of Part 141 of the Civil Aviation Regulations (CAR) 2011 as amended.

The ZS-PXI was broadcasting on the very high frequency (VHF) 125.80-Megahertz (MHz). Another pilot (pilot-in-command) who was flying an aircraft with registration ZS-CPL from the same aviation training organisation (ATO) as the ZS-PXI called the pilot (ZS-PXI) to remind him to change his frequency to 122.35 MHz when entering FAD 182, which he acknowledged.

According to the Secondary Surveillance Radar (SSR), the two aircraft collided at approximately 17:11:29Z and about 1.4 nautical miles (nm) north-east of the GAV beacon at an altitude of 6 700 feet (ft). There were no witnesses to this accident. The two student pilots and the two instructions on-board both aircraft were fatally injured. Both aircraft were destroyed during the accident sequence.

Probable Cause and Contributory Factors

Probable cause

The ZS-PXI and ZS-OMN aircraft collided mid-air while flying in the FAD 182 and, subsequently, crashed on the ground.

Contributing factors

The ZS-PXI aircraft was not on the designated VHF for danger area (FAD 182); therefore, the other traffic in the vicinity was not aware of its presence. Even if both crew had broadcasted their intentions at the time leading to the collision, they would have been unable to ensure adequate separation because they were not on the same frequency; therefore, they would have not heard each other.

The flight path data does not show either of the aircraft had initiated an evasive manoeuvre, which suggests that the pilots of both aircraft had no visual of each other, and hence, could not take action to avoid the collision.

SRP Date	12 July 2022	Publication Date	29 August 2022

Occurrence Details

Reference number	**:** CA18/2/3/9990
Occurrence Category	**:** Category 1
Type of operation	**:** Training Flight (Part 141)
Name of operators	**:** Central Flying Academy and Skyhawk Aviation
Name of owners	**:** South African General Aviation & Papa Charlie Partnership
Registration markings	**:** ZS-OMN and ZS-PXI
Manufacturer	**:** Cessna Aircraft Company
Model	**:** 172M (both aircraft)
Nationality	**:** South African
Place	**:** Kaalfontein Farm, Vanderbijlpark District, Gauteng Province
Date and Time	**:** 26 April 2021 and 1711Z
Injuries	**:** Fatal
Damage	**:** Destroyed

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****.*

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.

Investigation Process:

The accident was notified to the Accident and Incident Investigations Division (AIID) on 26 April 2021 at about 1906Z. The investigation team dispatched to the accident scene in Kaalfontein Farm the following morning to conduct an on-site investigation. The investigators co-ordinated with all authorities on site by initiating the accident investigation process according to Part 12 of the CAR and investigation procedures. The AIID 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:

- *Accident — this investigated accident*
- *Aircraft — the two Cessna 172M involved in this accident*
- *Investigation — the investigation into the circumstances of this accident*
- *Pilot — the pilot involved in this accident*
- *Report — this accident report*

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

Disclaimer:

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ABBREVIATION	DESCRIPTION
°C	Degrees Celsius
AGL	Above Ground Level
AIID	Accident and Incident Investigations Division
AIP	Aeronautical Information Publication
AMO	Aircraft Maintenance Organisation
ARCC	Aeronautical Rescue Co-ordination Centre
ATC	Air Traffic Control
ATNS	Air Traffic Navigation Services
ATO	Aviation Training Organisation
C of A	Certificate of Airworthiness
C of R	Certificate of Registration
CAR	Civil Aviation Regulations
CAVOK	Ceiling and Visibility OK
CPL	Commercial Pilot Licence
CRS	Certificate of Release to Service
CTAF	Common Traffic Advisory Frequency
CVR	Cockpit Voice Recorder
FAD	FA - ICAO code for SA D-Danger Area
FAGM	Rand Aerodrome
FALA	Lanseria International Aerodrome
FAPS	Potchefstroom Aerodrome
FARG	Rustenburg Aerodrome
FAWA	Warmbaths Aerodrome
FAWB	Wonderboom Aerodrome
FDR	Flight Data Recorder
Ft	Feet
GAV	Golf Alpha Victor Beacon
GPS	Global Positioning System
hPa	Hectopascal
IFR	Instrument Flight Rules
IIC	Investigator-in-charge
ILS	Instrument Landing System
IMC	Instrument Meteorological Conditions
Km	Kilometre
Kts	Knots
M	Metre
METAR	Meteorological Aerodrome Report
MHz	Megahertz
MPI	Mandatory Periodic Inspection
NOSIG	No Significant Change
PF	Pilot Flying
PIC	Pilot-in-command
PPL	Private Pilot Licence
SACAA	South African Civil Aviation Authority
SAPS	South African Police Service
SAWS	South African Weather Service
SSR	Secondary Surveillance Radar
TBO	Time Between Overhaul
VFR	Visual Flight Rules
VHF	Very High Frequency

VMC	Visual Meteorological Conditions
VOR	Very High Frequency Omni-directional Range
Z	Zulu (Term for Universal Coordinated Time - Zero hours Greenwich)

1. FACTUAL INFORMATION

1.1. History of Flight

1.1.1 On Monday, 26 April 2021 at 1641Z, a Cessna 172M aircraft with registration ZS-PXI departed Lanseria International Aerodrome (FALA) on a training flight. The crew had filed a flight plan and were assigned a squawk code 4012. The planned route was as follows: take-off from FALA to Johannesburg flying training area (FAD 182) near Grasmere Golf Alpha Victor (GAV) very high frequency omnidirectional radio range (VOR) beacon; Grand Central Aerodrome (FAGC); Warmbaths Aerodrome (FAWA); Rustenburg Aerodrome (FARG); and back to FALA. On-board the aircraft were a flight instructor and a private pilot who was training for his night rating by undertaking a dual cross-country navigational flight (Exercise 18A).

1.1.2 At 1650Z on the same evening, a Cessna 172M aircraft with registration ZS-OMN departed Rand Aerodrome (FAGM) on a training flight to the same flying training area (FAD 182). On-board the aircraft were a flight instructor and a private pilot who was training for his instrument rating (Exercise 19). The intention of the crew was to conduct air work in the FAD 182 and, later, return to FAGM.

1.1.3 The ZS-PXI routed as per the flight plan and entered FAD 182 at 17:00:50Z, flying a heading of 210° tracking an inbound of 030° towards the GAV beacon at an altitude of 6 700 feet (ft). At 17:09:44Z, the aircraft could be seen on the Secondary Surveillance Radar (SSR) set to commence a left turn. Approximately 1 minute later, the aircraft completed the turn and flew a heading of 030°, remaining on the same altitude of 6 700ft. According to radar data, the aircraft was flying at a ground speed of 95 knots (kts) at the time. The pilot-in-command (PIC) who was flying an aircraft with registration ZS-CPL from the same aviation training organisation (ATO) called the pilot of ZS-PXI on the very high frequency (VHF) 125.80-Megahertz (MHz) and reminded him to change frequency to 122.35 MHz when entering FAD 182, which he acknowledged.

1.1.4 The pilot flying the ZS-CPL aircraft as well as the pilot flying the ZS-FIF aircraft (which was also in the vicinity) heard the pilot of the ZS-PXI broadcast a Mayday call on VHF 125.80 MHz. The pilot of the ZS-CPL aircraft then relayed this information to air traffic control (ATC) at FALA on frequency 124.00 MHz, who then informed the Aeronautical Rescue Co-ordination Centre (ARCC) to activate an official search and rescue for the ZS-PXI aircraft. In the meantime, FALA ATC called all the aircraft flying in the FAD 182 Johannesburg flying training area on VHF 122.35 MHz to look out for the ZS-PXI aircraft. As it was nighttime, neither of the aircraft that were in the area could locate the ZS-PXI aircraft. The ZS-CPL pilot asked the crew of the ZS-STX if they have seen or heard the ZS-PXI at any time of their flight. The ZS-STX instructor replied “negative” and the ZS-STX instructor asked the ZS-KBW instructor if they have seen or heard from the ZS-PXI. The crew of ZS-KBW also

answered “negative”. The ZS-KBW aircraft was overhead Potchefstroom Aerodrome (FAPS) at the time. The crew members of ZS-STX and ZS-KBW noted that the moon was bright and the flight instructor on-board the ZS-STX was able to see the GAV beacon from 6 500ft above.

1.1.5. From the SSR data, the ZS-OMN aircraft could be seen entering FAD 182 at 17:05:40Z, flying a heading of 250° tracking an inbound of 070° towards GAV beacon at an altitude of 6 700ft and at a ground speed of 90kts. The aircraft was observed turning right by approximately 40° and maintaining a heading of 290°. There were two other aircraft in the vicinity but were not identifiable in the SSR; one was at 7 500ft, and the other aircraft’s altitude was not clear.

1.1.6. According to the SSR data, the two aircraft collided at approximately 17:11:29Z, 1.4 nautical miles (nm) north-east of the GAV beacon at an altitude of 6 700ft. There were no witnesses to this accident. The pilots (a total of four) on-board the two aircraft were fatally injured.

1.1.7 The wreckage of the ZS-OMN aircraft was located first as the aircraft had set the maize field alight on the farm where it had crashed. The wreckage of the ZS-PXI aircraft was located several hours later by the South African Police Service (SAPS) helicopter that was dispatched to the area. The crew located the wreckage by making use of the Nightsun (searchlight) light that was installed on the helicopter. Both aircraft were destroyed during the accident.

1.1.8 The accident occurred at night in VMC and at a Global Positioning System (GPS) co-ordinates determined to be 26°29’44.05” South 027°43’00.30” East, at an altitude of 6 700ft.

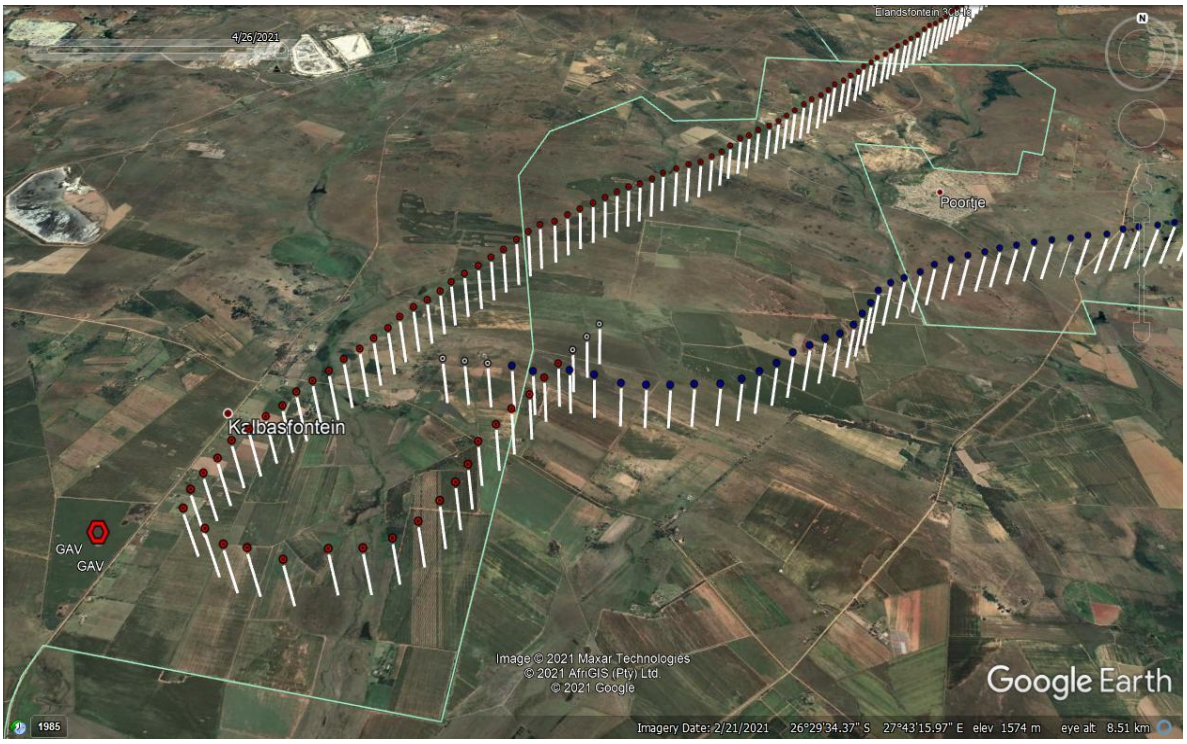

Figure 1: Radar data showing the ZS-PXI path in red dotted track; and ZS-OMN path in blue dotted track. (Source: ATNS)

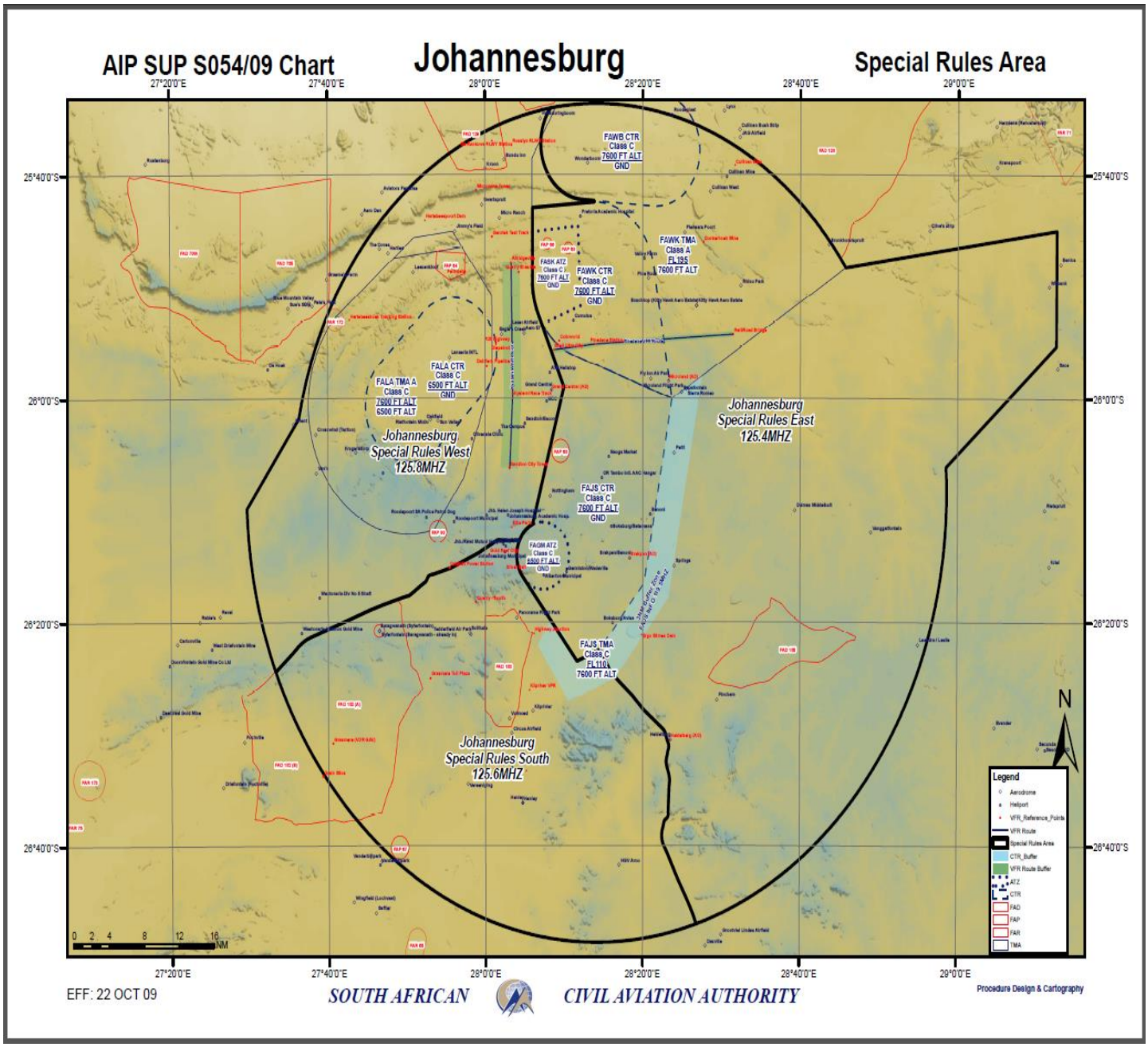

Figure 2: Airspace map indicating the accident site within the Johannesburg flying training area (FAD 182).

1.2. Injuries to Persons

Injuries	Pilots	Crew	Pass.	Total On-board	Other
Fatal	4	-	-	4	-
Serious	-	-	-	-	-
Minor	-	-	-	-	-
None	-	-	-	-	-
Total	4	-	-	4	-

Note: Other means people on the ground.

1.3. Damage to Aircraft

1.3.1 The ZS-OMN aircraft was destroyed by impact forces and the post-impact fuel-fed fire.

Figure 3: The wreckage of the ZS-OMN aircraft as it came to rest in an inverted attitude.

1.3.2 The ZS-PXI aircraft was also destroyed when it impacted a rocky terrain in a steep nose-down attitude.

Figure 4: The wreckage of the ZS-PXI as it came to rest.

1.4. Other Damage

1.4.1 A section of the maize crop field on which the ZS-OMN aircraft crashed was destroyed by post-impact fuel-fed fire.

Figure 5: Some of the maize crops that were destroyed by the post-impact fire.

1.5. Personnel Information

1.5.1 Pilot-in-command (PIC) / Flight Instructor of ZS-OMN

Nationality	South African	Gender	Male	Age	31
Licence Type	Commercial Pilot Licence				
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	Instrument, Flight Instructor Grade II				
Medical Expiry Date	31 August 2021 (Class 1)				
Restrictions	None				
Previous Accidents	None				

Note: Previous accidents refer to past accidents the pilot was involved in, when relevant to this accident.

1.5.1.1 The pilot-in-command's last skills test/revalidation check report for his flight instructor rating was conducted on 20 April 2021. He was found to be proficient by a designated flight examiner (DFE).

Flying Experience:

Total Hours	1 902.5
Total Past 90 Days	100.9
Total on Type Past 90 Days	100.9
Total on Type	1 022.9

1.5.2 Student Pilot of ZS-OMN

Nationality	Saudi Arabian	Gender	Male	Age	31
Licence type	Private Pilot Licence				
Licence valid	Yes	Type endorsed	Yes		
Ratings	None				
Medical expiry date	11 December 2023 (Class 2)				
Restrictions	None				
Previous accident	None				

1.5.2.1 The student pilot undertook a Private Pilot Licence (PPL) flight test on 12 January 2021, which he passed successfully.

Flying experience:

Total hours	79.6
Total past 90 days	6.9
Total on type past 90 days	6.9
Total on type	79.6

1.5.2.2 The last entry in the student pilot's logbook was dated 14 March 2021. According to available information, the ZS-OMN aircraft was airborne for 21 minutes from take-off until the time of the accident; this flight time was added to his total flying hours.

1.5.3 Pilot-in-command (PIC) / Flight Instructor of ZS-PXI

Nationality	South African	Gender	Male	Age	24
Licence type	Commercial Pilot Licence				
Licence valid	Yes	Type endorsed	Yes		
Ratings	Instrument, Flight Instructor Grade II				
Medical expiry date	30 June 2021 (Class 1)				
Restrictions	None				
Previous accident	None				

Flying experience:

Total hours	685.2
Total past 90 days	77.6
Total on type past 90 days	73.9
Total on type	412.7

1.5.3.1 A few pages of the pilot-in-command's logbook were recovered from the wreckage where it was noted that the last entry was on 23 April 2021. According to available information, the ZS-PXI aircraft was airborne for 30 minutes from take-off until the time of the accident; this flight time was added to his total flying hours.

1.5.4 Student Pilot of ZS-PXI

Nationality	Indian	Gender	Male	Age	21
Licence type	Private Pilot Licence				
Licence valid	Yes	Type endorsed	Yes		
Ratings	None				
Medical expiry date	30 September 2022 (Class 2)				
Restrictions	Must wear corrective lenses during flight				
Previous accident	None				

Flying experience:

Total hours	95.9
Total past 90 days	9.1
Total on type past 90 days	4.1
Total on type	90.9

1.5.4.1 According to available information, the student pilot's logbook was last updated on 25 April 2021, a day before the accident flight. The 30 minutes flight time from take-off until the time of the accident was added to his total flying hours.

1.6. Aircraft Information

1.6.1 Cessna 172M, ZS-OMN

The Cessna 172M is a four-seat, high-wing aircraft fitted with a tricycle-undercarriage and a Lycoming O-320-E2D reciprocating engine driving a constant-speed, two-bladed propeller. This aircraft was manufactured by the Cessna Aircraft Company in the United States in 1974.

Figure 6: The Cessna 172M, ZS-OMN.

1.6.2 Airframe of ZS-OMN:

Manufacturer/Model	Cessna Aircraft Company/ Cessna 172M	
Serial Number	172-62997	
Year of Manufacture	1974	
Total Airframe Hours (at time of accident)	15 431.5	
Last Inspection (hours & date)	15 355.4	10 March 2021
Airframe Hours Since Last Inspection	76.1	
CRS Issue Date	25 November 2020	
C of A (issue date)	21 August 2003	
C of A (expiry date)	31 August 2021	
C of R (issue date) (Present owner)	27 March 2013	
Operating Categories	Standard Normal (Aeroplane)	
Type of Fuel Used in the Aircraft	Avgas	
Previous Accidents	On 10 February 2010, a student pilot lost directional control of the aircraft during landing on Runway 17 at Grand Central Aerodrome, and the aircraft collided with the perimeter fence.	

Note: Previous accidents refer to past accidents the aircraft was involved in, when relevant to this accident.

1.6.2.1 The flying hours since the last maintenance inspection were obtained from the flight folio.

Engine:

Manufacturer/Model	Lycoming O-320-E2D
Serial Number	L-34958-27A
Hours Since New	Unknown
Hours Since Overhaul	1 174.5

Propeller:

Manufacturer/Model	McCauley 1C16 DTM 7553
Serial Number	AHD 44011
Hours Since New	Unknown
Hours Since Overhaul	1 174.5

1.6.2.2 According to the aircraft fuel receipt, the ZS-OMN aircraft had uplifted 61 litres of AVGAS prior to the accident flight.

1.6.3 Cessna 172M, ZS-PXI

The Cessna 172M is a four-seat, high-wing aircraft fitted with a tricycle-undercarriage and a Lycoming O-320-E2D reciprocating engine driving a constant-speed, two-bladed propeller. This aircraft was manufactured by the Cessna Aircraft Company in the United States in 1974.

Figure 7: The Cessna 172M, ZS-PXI.

1.6.4 Airframe of ZS-PXI:

Manufacture/Model	Cessna Aircraft Company / 172M	
Serial number	172-63542	
Year of manufacture	1974	
Total airframe hours (at time of accident)	16 062.6	
Last Inspection (hours & date)	15 994.2	13 April 2021
Airframe Hours Since Last Inspection	68.4	
CRS Issues Date	16 September 2020	
C of A (issue date)	20 December 2011	

C of A (expiry date)	31 December 2021
C of R (issue date) (Present owner)	14 August 2007
Operating Categories	Standard Normal (Aeroplane)
Type of Fuel Used in the Aircraft	Avgas
Previous Accidents	On 9 July 2011, following a hard landing at Lanseria International Aerodrome, the left main gear strut broke off and the left wing impacted the ground; the empennage was also damaged.

1.6.4.1 The flying hours since the last maintenance inspection were obtained from the flight folio.

Engine:

Manufacturer/Model	Lycoming O-320-E2D
Serial Number	L-25724-27A
Hours Since New	3 274.9
Hours Since Overhaul	1 612.9

Propeller:

Manufacturer/Model	McCauley 1C160/ DTM 7553
Serial Number	AKK 44011
Hours Since New	2 590.6
Hours Since Overhaul	568.1

1.6.4.2 According to the weight and balance for this flight, the aircraft had approximately 140 litres (37 US gallons) of fuel on-board prior to the flight.

1.7. Meteorological Information

1.7.1 An official weather report was obtained from the South African Weather Service (SAWS).

The forecast meteorological conditions for the Johannesburg flying training area (FAD 182) on the day indicated clear conditions in the area of the accident with no significant weather or aviation hazards. The wind forecast ranged between 5-10 knots (kts) at flight level (FL) 050; and 10-15kt between FL180 and FL100. This signifies no indication of moderate or severe turbulence in the respective levels. The area of interest was clear of turbulence. Full moon conditions prevailed, and visibility was described as good according to other pilots who were flying in the area at the time.

1.7.2 The meteorological aerodrome report (METAR) for FALA at 1700Z on 26 April 2021 was as follows:
FALA 261700Z 27003KT 230V290 CAVOK 19/M00 Q1021 NOSIG=

Wind direction	270°	Wind speed	3kts	Visibility	+ 10km
Temperature	19°C	Cloud cover	Nil	Cloud base	Nil
Dew point	0°C	QNH	1021hPa		

1.7.3 According to the website: www.timeanddate.com/moon/phases/south-africa/2021, it was full moon on the evening of the fatal accident. It was further noted that there was a Super Full Moon at 05:31 on 27 April 2021.

1.8. Aids to Navigation

1.8.1 Both aircraft were equipped with standard navigational equipment as approved by the Regulator (SACAA). There were no records indicating that the navigational equipment was unserviceable prior to the flights.

1.8.2 The GAV VOR beacon, which was close to the accident site, was operating adequately at the time of the accident.

1.9. Communication

1.9.1 Both aircraft were equipped with standard communication equipment as approved by the Regulator.

1.9.2 Both aircraft were fitted with transponders. The ZS-PXI aircraft was allocated a squawk code 4012, which was detected by SSR radar; and the ZS-OMN aircraft was squawking 2000.

1.9.3 A designated Common Traffic Advisory Frequency (CTAF) was used in the Johannesburg flying training (FAD 182), which was 122.35 MHz when flying between ground level and at an altitude 7 600ft. This is a frequency on which pilots make positional broadcasts when operating in this area. *For reference, please see the Aeronautical Information Publication (AIP) ENR 5.1-30, which is attached to this report as Annexure A.*

1.9.4 Radio transmissions were not recorded as both aircraft were flying outside of the controlled airspace at the time of the accident.

1.9.5 The instructor of the ZS-PXI aircraft broadcasted a Mayday call on frequency 125.80 MHz. This call was heard by other aircraft that were airborne and operating in the same area at the time of the accident.

1.9.6 The instructor of ZS-OMN was heard broadcasting while entering the Johannesburg flying training area (FAD 182) on the VHF 122.35 MHz by two other aircraft that were operating in the same area, also engaged in training.

1.9.7 Both aircraft were fitted with VHF/COM Bendix King radio Part Number KX155TSO. There were no reported defects on both radios prior to the accident.

1.10. Aerodrome Information

1.10.1 This accident did not occur at or close to an aerodrome.

1.11. Flight Recorders

1.11.1 Neither of the two aircraft was equipped with flight data recorders (FDR) or cockpit voice recorders (CVR), nor were these required by regulation.

1.12 Wreckage and Impact Information

1.12.1 At approximately 17:11:29Z, the left wing of the ZS-PXI aircraft collided with the left aft fuselage of the ZS-OMN, which caused the entire left horizontal stabiliser and elevator assembly to break off. The ZS-PXI was flying a heading of 030° and the ZS-OMN was at a heading of 250°, and both aircraft were at an altitude of 6 700ft (see Figure 18).

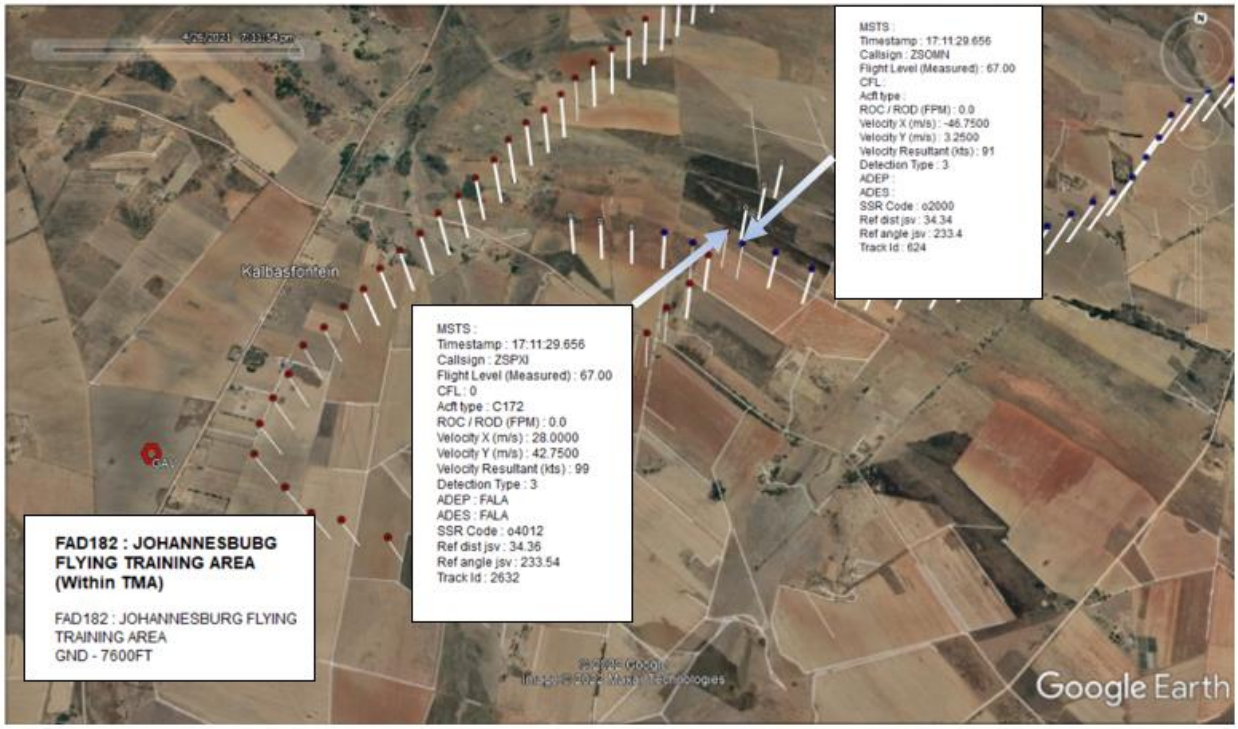

Figure 8: Point of collision from the Radar data. Both aircraft's altitude was 6700ft. (Source: ATNS)

1.12.2 Following the mid-air collision, the ZS-PXI travelled approximately 600 metres (m) horizontally before impacting terrain in a steep nose-down attitude on an open field, while the ZS-OMN crashed in a maize field.

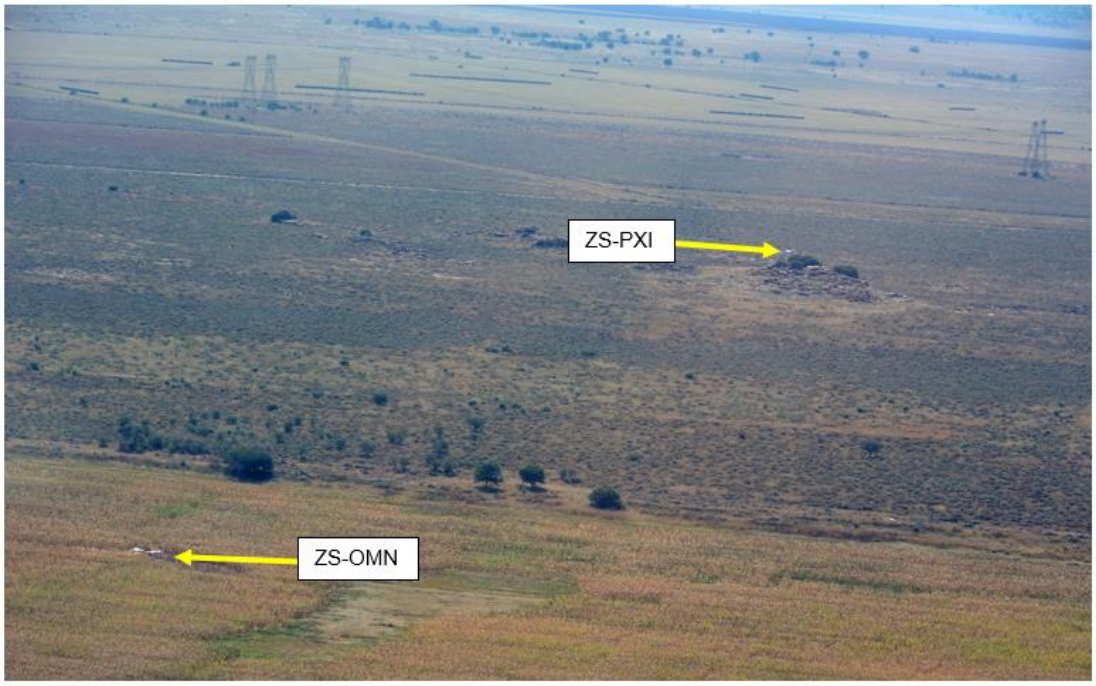

Figure 9: An aerial view indicating the two wreckages.

Figure 10: An aerial picture of the wreckage of the ZS-OMN aircraft.

1.12.3 The left-side wing tip of the ZS-PXI severed the left-side horizontal stabiliser of the ZS-OMN.

Figure 11: The empennage of the ZS-OMN displaying the hardware deformation where the left horizontal stabiliser was installed.

1.12.4 The entire left horizontal stabiliser of the ZS-OMN aircraft with the elevator still attached was located 155m towards the north of the main wreckage impact point.

1.12.5 The left-wing tip fairing of the ZS-PXI aircraft was located approximately 15m from the ZS-OMN left horizontal stabiliser.

Figure 12: The left ZS-PXI left-wing tip fairing on the left of the picture, and the ZS-OMN horizontal stabiliser on the right of the picture.

Figure 13: The left-wing tip fairing of the ZS-PXI aircraft.

Figure 14: The left horizontal stabiliser and elevator of the ZS-OMN aircraft.

1.12.6 The right-wing tip fairing of the ZS-PXI aircraft was located next to the wreckage.

Figure 15: The ZS-PXI wreckage with the right-wing tip next to it in the yellow window.

1.12.7 Figures 16 and 17 confirm that the left-wing leading edge of the ZS-PXI impacted the aft fuselage of the ZS-OMN in a wings level attitude. During the impact sequence, the left horizontal stabiliser of the ZS-OMN was severed from the fuselage, which compromised the entire aft structural integrity of the aircraft. During reconstruction of the ZS-OMN aircraft, the left horizontal assembly was recovered and placed in position (see Figure 18).

Figure 16: The impact markings caused by the left-wing leading edge of the ZS-PXI on the left aft fuselage of the ZS-OMN.

Figure 17: The compressed left-wing leading edge of the ZS-PXI that impacted the ZS-OMN, leaving traces of the blue paint of the registration mark on it.

Figure 18: The left horizontal stabiliser was recovered and placed in position during reconstruction.

1.13 Medical and Pathological Information

1.13.1 Post-mortem examination determined that all four pilots succumbed from blunt force injuries, consistent with high energy impact.

1.14 Fire

1.14.1 The ZS-OMN aircraft was partially consumed by post-impact fuel-fed fire.

1.14.2 There was no evidence of a pre- or post-impact fire damage on the ZS-PXI aircraft.

1.15 Survival Aspects

1.15.1 Given the nature of the mid-air collision and the subsequent ground impact, the accident was not survivable for any of the four pilots.

1.15.2 There were no eyewitnesses to this accident. The wreckage of the ZS-OMN was discovered when farm workers went to douse the fire after the maize field was set alight by post-impact fire.

1.15.3 At that stage, it was not known that a second aircraft was involved in the accident. The wreckage of the ZS-PXI was only discovered several hours later after police officials arrived on site and after information was received that a second aircraft could have been involved. A police helicopter crew spotted the ZS-PXI wreckage several hours after the wreckage of the ZS-OMN was found.

1.15.4 The fire and rescue services assisted in cutting open the wreckage of the ZS-PXI using jaws-of-life. The aircraft impacted the ground in a steep nose-down attitude.

1.16 Tests and Research

1.16.1 Source: Airplane Flying Handbook (FAA-H-8083-3C)

Night Blind Spot

The "Night Blind Spot" appears under conditions of low ambient illumination due to the absence of rods in the fovea. [Figure 11-3] This absence of rods affects the central 5 to 10 degrees of the visual field. If an object is viewed directly at night, it may go undetected or it may fade away after initial detection. The night-blind spot can hide larger objects as the distance between the pilot and an object increases.

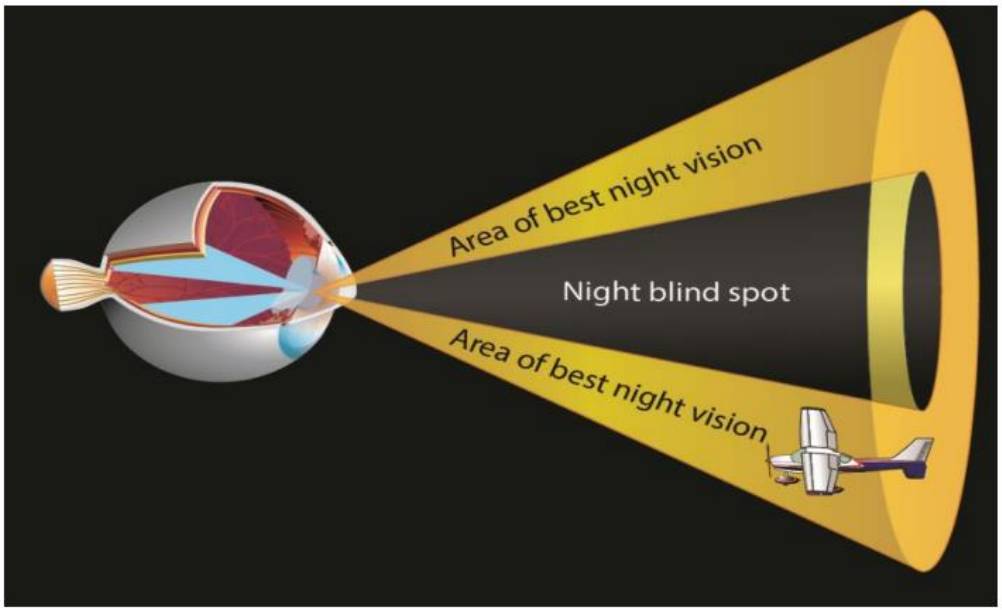

Figure 11-3. The night-blind spot.

Airplane Equipment and Lighting

14 CFR part 91, section 91.205(c) specifies the basic minimum airplane equipment that is required for VFR flight at night. This equipment includes basic instrument, lights, electrical energy source, and spare fuses if applicable. 11-5 The standard instrument required by 14 CFR part 91, section 91.205(d) for IFR flight are valuable assets for aircraft control at night. 14 CFR part 91, section 91.205(c)(3) specifies that during VFR flight at night, operating aircraft are required to have an approved anti-collision light system, which can include a flashing or rotating beacon and position lights. However, 14 CFR part 91, section 91.209(b) gives the pilot-in-command leeway to turn off the anti-collision lights in the interest of safety. Airplane position lights are arranged similar to those of boats and ships. A red light is positioned on the left wingtip, a green light on the right wingtip, and a white light on the tail. [Figure 11-4]

Figure 11-4. Position lights.

This arrangement provides a means to determine the general direction of movement of other airplanes in flight. If both a red and green light of another aircraft are observed, and the red light is on the left and the green to the right, the airplane is flying the same direction. Care must be taken to maintain clearance. If red were on the right and green to the left, the airplane could be on a collision course.

Landing lights are not only useful for taxi, take-offs, and landings, but also provide a means by which airplanes can be seen at night by other pilots. Pilots are encouraged to turn on their landing lights when operating within 10 miles of an airport and below 10,000 feet. Operation with landing lights on applies to both day and night or in conditions of reduced visibility. This should also be done in areas where flocks of birds may be expected.

Although turning on aircraft lights supports the "see and be seen" concept, pilots should continue to keep a sharp lookout for other aircraft. Aircraft lights may blend in with the stars or the lights of the cities at night and go unnoticed unless a conscious effort is made to distinguish them from other lights.

Source: https://www.mcfarlaneaviation.com/articles/aeroleds-about-ped/content/

Pulse Recognition Mode

AeroLEDs lights with pulse mode (or wig-wag mode) greatly improve safety by alternately blinking the left then right light once per second. This dramatically increases your aircraft visibility to prevent both air and ground collisions. At least one 36HX or 46HX series light must be installed to enable pulse mode.

1.17 Organisational and Management Information

1.17.1 Both flights were training flights conducted under the provisions of Part 141 of the CAR 2011 as amended.

1.17.2 The ZS-OMN aircraft was authorised to operate under the ATO certificate SACAA/1023/ATO-1 with an effective date of 1 December 2020 and an expiry date of 30 April 2022.

1.17.3 The ZS-PXI aircraft was authorised to operate under the ATO certificate SACAA/1147/ATO-1 with an effective date of 31 March 2021 and an expiry date of 31 March 2026.

1.17.4 The last maintenance inspection that was carried out on the ZS-OMN aircraft prior to the accident flight was certified on 10 March 2021 at 15 355.4 airframe hours. The aircraft maintenance organisation (AMO) that certified the inspection was in possession of an AMO approval certificate No. 0071, issued by the SACAA on 7 April 2021 with an expiry date of 31 March 2022.

1.17.5 The last maintenance inspection that was carried out on the ZS-PXI aircraft prior to the accident flight was certified on 13 April 2021 at 15 994.2 airframe hours. The AMO that certified the inspection was in possession of an AMO approval certificate No. 0622 that was issued by the SACAA on 16 July 2020 with an expiry date of 31 July 2021.

1.18 Additional Information

1.18.1 Airspace Classification South Africa

Airspace in South Africa is divided into different classes that may be either controlled (Class A, Class C, Class D, Class E) or non-controlled (Class G). Different services are offered to aircraft that operate in these airspace classes, based on the flight rules the aircraft is operating under (titled Air traffic services).

Source: Aeronautical Information Publication (AIP) South Africa ENR 1.4-1 dated 15 October 2018

ATS airspace within the boundaries of the Republic of South Africa (RSA) will be classified in accordance with the ICAO standards.

ICAO airspace classifications not in use within the RSA are indicated accordingly.

***Class A**: All controlled airspace FL200 and above or as designated (prohibited for VFR flights).*

Class B: *All controlled airspace below FL200 in the case of a controlled traffic region (CTR).*

Class C: *All controlled airspace below FL200. In the case of an aerodrome traffic zone (ATZ), aerodrome separation will be applied.*

Class D: *All controlled airspace below FL200 in the case of an ATZ.*

Class E: *not in use in South Africa.*

Class F*: Advisory services will be provided.*

Class G: *All information airspaces.*

1.18.2 Source: **FLIGHT INSTRUCTOR'S MANUAL OF TRAINING PROCEDURES**
Revised by Wouter Gous, Bob Ewing and Lee-Anne Dixon 29 June 2009

EXERCISE 18A

AIM

DEFINITION

Navigation is the process of directing the movement of an aircraft from one point to another.

WHAT THE INSTRUCTOR IS TO TEACH

i. Discuss the basic navigation principles enumerated in the Private Pilot's licence syllabus
j.

Note: The student should have already received adequate ground instruction in the principles of pilotnavigation prior to undertaking the first dual navigation flight – the aim now is to teach him to apply this knowledge in the air.

ii. The air exercise briefing:
a. Applicable procedures and check lists.
b. Preparation for a navigation flight, emphasising the following aspects:
- *Weather forecast*
- *Map preparation, i.e. distance graduation, high terrain, etc.*
- *Computation of compass heading, ground speed and flight times.*
- *Assessment of safety heights and semi-circular rule.*
- *Heading correction methods – drift problems.*
- *Fuel required and reserves (refer to CAR's and CAT's).*
- *Uses and limitations for en-route radio navigational aids.*
- *Review of applicable VFR requirements and regulations.*
- *Procedure when lost.*
- *Use of take-off graphs and compilation of load sheet.*
- *Diversion procedure.*
- *Power settings to be used for navigation flights.*
- *Pilot-navigation log and ATC flight plan.*

c. Engine considerations, safety and airmanship.
d. Similarity to previous exercises.
e. De-briefing after flight.

WHY IT IS BEING TAUGHT
To teach the student to fly from one place to another using simple pilot navigation techniques, whilst relying on the minimum of artificial aids.

HOW THE EXERCISE APPLIES TO FLYING

i. The techniques taught should form the basis of all subsequent cross-country flights.
ii. Low level navigation.
iii. Night navigation flights.
iv. Instrument navigation flights.

CONSIDERATIONS OF AIRMANSHIP AND ENGINE HANDLING AIRMANSHIP

i. Look out.
ii. Radio calls.
iii. Log keeping.
iv. Maintaining altitude heading and airspeed.
v. Compliance with navigation procedures: when
a. Setting heading.
b. Check points.
c. Radio failure.
d. Procedure when lost.
e. Turning points.
vi. Align D.I. with magnetic compass at least every 10 minutes.
vii. Weather consideration – maintain visual contact with the ground.
viii. Map orientation and awareness of position.
ix. Use of D.R. navigational techniques.

EXERCISE 19
INSTRUMENT FLYING
AIM

The aim of this series of lessons under Exercise 19 is to give guidance to instructors of what to teach a student for the Night and Instrument Rating.

DEFINITION

Instrument flying is the process whereby the aircraft is controlled and navigated in flight solely by reference to instrument.

WHY IS IT BEING TAUGHT

To give the student a good understanding and a thorough knowledge of the principles required to fly the aircraft with sole reference to the instrument in an IFR environment.

HOW THE EXERCISE APPLIES TO FLYING
Night flying.
ii. Control of the aircraft in IFR conditions.
iii. Navigational.
iv. Instrument approach procedures.

CONSIDERATIONS OF AIRMANSHIP AND ENGINE HANDLING
AIRMANSHIP

The instructor must ensure that an adequate lookout is maintained particularly whilst the student is under the hood.
It is absolutely essential that the D.I. is synchronized with the compass about every 10 to 15 min.

1.18.3 Foggles

According to the ATO of the ZS-OMN aircraft, the student pilot was wearing foggles during this training flight for his night rating.

Source: https://www.amazon.com/Aviation-Flight-Training-Glasses-Meteorological/dp/B01HWWFYNG

Figure 19: Aviation Flight Training Glasses.

Foggles are glasses that have been made to simulate foggy conditions to the wearer and are used in pilot training exercises. Foggles are frosted on the top half to limit the field of vision of pilots and force them to use only the flight instrument, simulating the conditions of low ceiling of clouds, heavy fog, night, and other Instrument meteorological conditions (IMC). Under these conditions, pilots must fly under instrument flight rules (IFR), rather than by outside visual references under visual flight rules (VFR).

Civil Aviation Regulations:

Right of way

Part 91.06.7 (1) An aircraft which has the right-of-way, shall maintain its heading and speed, but nothing in these provisions shall relieve the PIC of an aircraft from the responsibility of taking such action as will best avert collision, including collision avoidance manoeuvres based on resolution advisories provided by ACAS equipment.

(2) An aircraft which is obliged, by the provisions of this Subpart, to keep out of the way of another aircraft, shall avoid passing over or under the other aircraft, or crossing ahead of such aircraft, unless passing well clear, taking into account the effects of wake turbulence.

(3) When two aircraft are approaching head-on or approximately so and there is danger of collision, ***each aircraft shall alter its heading to the right.***

Reducing the Risk of Mid-Air Collision

Source: www.bea.aero/etudes/abordageseng/midair.htm

In order to reduce the risk of mid-air collisions. First of all, considering the limitations of human sight which makes it difficult to spot an aircraft on a collision course, that is to say on a constant bearing, it is advisable to favor everything which can improve perception:

- *Use of all the means available in order to be spotted: revolving lights, navigation lights, beacons are an invaluable help; they allow other pilots or controllers to spot the aircraft much earlier.*
- *Cleaning the windshield: the study showed that an obstacle, even small, could hide a plane until it is too late to undertake avoidance manoeuvres. Flight documents and other objects placed above the instrument panel cause reflections that can hamper visibility through the windshield.*
- *Systematic use of radio. Contacts organized at the local level among VFR pilots and controllers, themselves often pilots as well, could lead to less reticence and facilitate the correct use of the flight information.*
- *Systematic use of the transponder, if it is available on board (and if it works with altitude displayed). This allows the controller to know about the traffic and can permit, as a last resort, the crew of a transport aircraft equipped with TCAS to detect conflicting traffic.*
- *Respect for the approach/arrival path and runway circuits, whatever the imperatives on profitability or schedule.*

Pilots in VFR or flying IFR in airspace where there can be VFR flights, should be made aware of the existence of the real risk of collision and of the importance of being vigilant at all times. Especially:

- *Alertness is necessary during the flight to ensure against collisions. For this purpose, good flight preparation, whether under VFR or under IFR, allows the workload to be decreased and, in particular, consultation of flight documentation.*
- *Perfect knowledge, regularly updated, of the airspaces is indispensable to know the requirements and services offered, as well as the interaction with other flights (by sight or by instrument).*
- *The level of vigilance should be increased around very busy zones (areas of radio navigation, aerodromes) and when the aircraft is flying with the sun behind its tail.*
- *The explicit sharing of outside monitoring is desirable before a flight with two persons.*

Finally, it would be advisable to improve the operation of the see-and-avoid rule, without underestimating the limitations. This comes about with good and regular training of private pilots in:

- *methodical execution of the outside monitoring. Dynamic monitoring favouring the search for a target is certainly more effective than a simple glance towards the sky. Pilots should be trained to search and detect,*
- *the correct execution of an avoidance manoeuvre. Pilots should be trained to appraise the relative movement of another aircraft and to conceive and quickly execute the correct avoidance manoeuvre.*

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. This shall not be read as apportioning blame or liability to any particular organisation or individual.

2.2 Man (pilots)

2.2.1 Before entering FAD 182, the ZS-PXI aircraft was communicating on VHF 125.80 MHz and the pilot flying the ZS-CPL aircraft reminded them to change their frequency to 122.35 MHz which was acknowledged. According to Bendix / King KX155TSO radio which was fitted to the ZS-PXI aircraft; to tune the COMM transceiver to the desired operating frequency, the selected frequency must first be entered into the "STBY" display window and then activated by pushing the "flipflop" transfer button. It is possible that the crew of the ZS-PXI had selected the correct frequency but omitted to push the "flipflop" button to activate the desired frequency. The instrument panel was destroyed by impact forces; therefore, the investigation team could not confirm whether the frequency was selected or not.

2.2.2 The crew of the ZS-OMN aircraft were conducting training for instrument rating (Exercise 19) and the student pilot was wearing foogles, which are frosted on the top-half to limit the field vision of pilots and force them to use only the flight instrument, simulating the conditions of low ceiling of clouds, heavy fog, night, and other instrument meteorological conditions (IMC). The student pilot was seated on the left, therefore, the foogles he was wearing made it impossible for him to see the ZS-PXI aircraft (as it approached) from the left-side. According to the flight instructor's manual of training procedures, the instructor must ensure that an adequate lookout is maintained, particularly whilst the student is under

the hood or wearing foogles. However, with the flight instructor sitting on the right-side of the aircraft, it was difficult for him to see the ZS-PXI aircraft which approached from the left. It is also possible that the instructor was engage with the student pilot's training and did not lookout for any traffic at that stage of the flight. The flight instructor of the ZS-PXI aircraft was reminded by another pilot (ZS-CPL) who was also airborne at the time from the same ATO that they should change their frequency to 122.35 MHz (FAD 182 frequency). The ZS-CPL pilot heard the MAYDAY call on frequency 125.80 MHz, which indicated that the crew of ZS-PXI did not change the frequency as advised earlier.

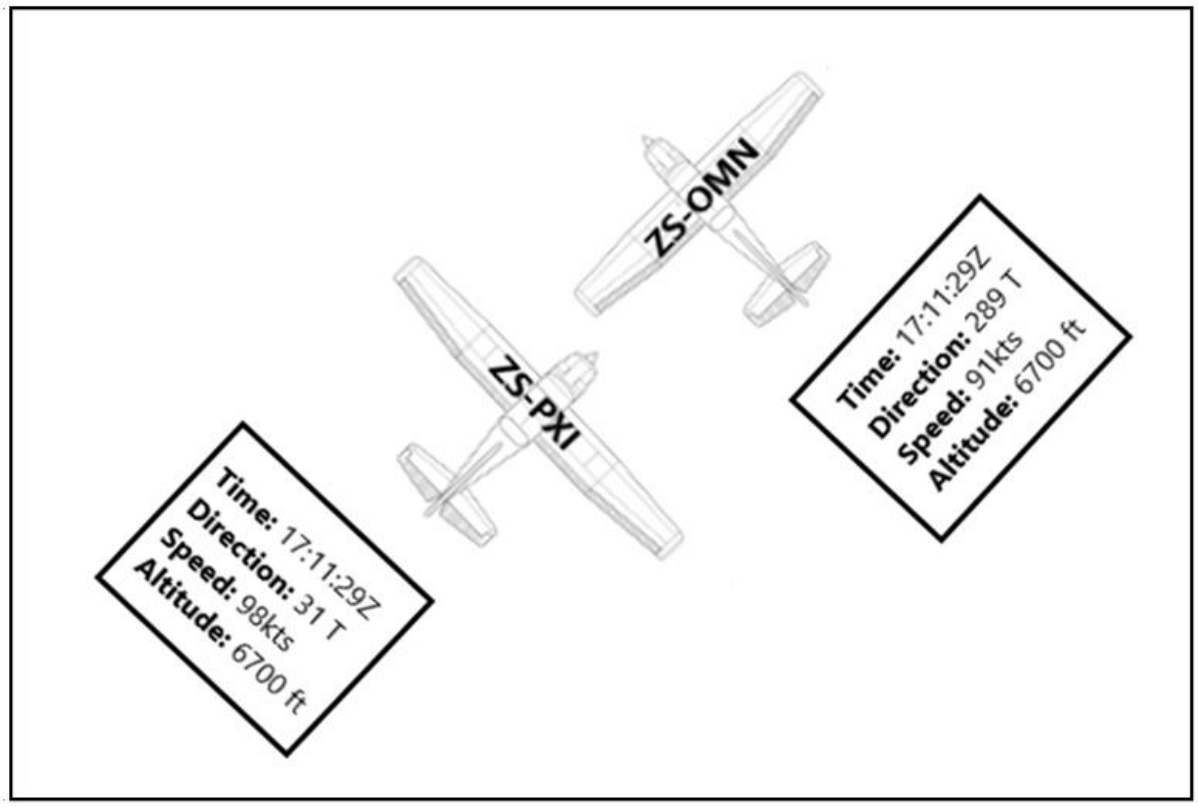

Figure 20: Aircraft position seconds before impact at 6 700ft.

It is likely that the crew of the ZS-PXI aircraft were occupied with navigational requirements of routing to their waypoint FAGC and did not see the ZS-OMN aircraft. At approximately 17:11:29Z, the time of impact, the ZS-OMN was positioned in level flight heading in a westerly direction when the left wing of the ZS-PXI impacted the left aft fuselage of the ZS-OMN.

2.2.3 The crew of the ZS-STX and ZS-KBW aircraft both remarked that the moon was bright and the flight instructor on-board the ZS-STX could see the GAV beacon from 6 500ft above. According to the Airplane Flying Handbook (FAA-H-8083-3C), "*If an object is viewed directly at night, it may go undetected or it may fade away after initial detection."* Therefore, it is possible that the crew of the ZS-PXI did not see the ZS-OMN aircraft directly in front of them, and the aircraft became more visible as they got closer. The use of brighter strobe lights might have made it possible for the crew of the ZS-PXI to see the ZS-OMN at first glance.

2.2.4 Aircraft

Both aircraft were maintained in accordance with the approved maintenance schedules. The on-site wreckage examinations did not identify any aircraft defects or anomalies that might have contributed to or have caused the accident.

2.2.5 Operational Environment

When operating in an uncontrolled airspace (such as the airspace in FAD 182), pilots are responsible for maintaining separation from other aircraft. The rules of the air require pilots to maintain a lookout for other aircraft when conditions permit, to not operate in a way that creates a hazard for other aircraft, and to monitor and broadcast in the appropriate frequency whenever it is reasonably necessary to avoid the risk of collision.

Both aircraft had experienced pilots on-board who had conducted similar operations many times before. All pilots were familiar with the operational environment and how to separate from other traffic. Significantly, a review of events leading up to the collision identified that the pilots of ZS-PXI aircraft have been communicating on a different frequency and, therefore, missed important information from other aircraft around them. The pilot of the ZS-CPL who was from the same ATO reminded the pilot of the ZS-PXI that he should change the frequency from 125.80 MHz to 122.35 MHz when entering FAD 182 but did not comply. Hence, he later heard the *Mayday* broadcast on frequency 125.80 MHz, which was evident that this information, which was acknowledge, was not complied with. The primary defence which requires that pilots broadcast their intentions on the correct frequency was found to be absent, as it was not possible to establish self-separation as required in uncontrolled airspace.

2.2.6 See-and-avoid

Both aircraft were flying in VMC conditions by night. Additionally, there was celestial illumination as it was full moon on the evening which, according to other pilots flying in the area, improved visibility to such a degree that one pilot could see the GAV beacon on the ground from 6 500ft above. With the prevailing conditions, they would have been expected to see-and-avoid, as there was no significant reason why the two aircraft could not see each other if their respective external lights were illuminated, which would have been met as it is part of the before take-off checklist.

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 conclusion heading:

- **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.
- **Causes —** are actions, omissions, events, conditions or a combination thereof, which led to this accident.
- **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 occurring, or would have mitigated the severity of the consequences of the accident. The identification of contributing factors does not imply the assignment of fault or the determination of administrative, civil or criminal liability.

3.2. Findings

The ZS-PXI crew

3.2.1 The PIC was issued a Commercial Pilot Licence (CPL) on 18 June 2018. According to his logbook, he had flown a total of 685.2 hours of which 412.7 hours were on the aircraft type.

3.2.2 The PIC was issued a valid Class 1 aviation medical certificate on 30 June 2020 with an expiry date of 30 June 2021.

3.2.3 The PF was issued a Private Pilot Licence (PPL) on 8 September 2020. According to his logbook, he had flown a total of 95.9 hours.

3.2.4 The PF was issued a valid Class 2 aviation medical certificate on 1 September 2019 with an expiry date of 30 September 2022.

3.2.5 The flight was authorised and both crew members had signed the authorisation sheet prior to the flight.

3.2.6 The crew of the ZS-PXI aircraft had filed a flight plan for the cross-country navigational flight.

The ZS-OMN crew

3.2.7 The PIC was issued a Commercial Pilot Licence (CPL) on 29 June 2016. According to his logbook, he had flown a total of 1 902.5 hours, of which 1 022.9 hours were on the aircraft type.

3.2.8 The PIC was issued a valid Class 1 aviation medical certificate on 28 August 2020 with an expiry date of 31 August 2021.

3.2.9 The PF was issued a Private Pilot Licence (PPL) on 12 January 2021. According to his logbook, he had flown a total of 79.6 hours. All his flying hours were on a Cessna 172.

3.2.10 The PF was issued a valid Class 2 aviation medical certificate on 11 December 2018 with an expiry date of 11 December 2023.

3.2.11 The flight was accordingly authorised and both crew members had signed the authorisation sheet prior to their flights.

The ZS-PXI aircraft

3.2.12 The aircraft was issued a Certificate of Airworthiness on 12 December 2011 with an expiry date of 31 December 2021.

3.2.13 The aircraft was issued a Certificate of Release to Service on 13 April 2021 with an expiry date of 13 April 2022 or at 16 094.0 airframe hours, whichever comes first.

3.2.14 The aircraft was issued a Certificate of Registration on 14 August 2007.

3.2.15 The last scheduled maintenance inspection carried out on the aircraft prior to the accident flight was certified on 13 April 2021 at 15 994.2 airframe hours. The aircraft had accumulated an additional 68.4 airframe hours since the said inspection.

3.2.16 According to statements received from other pilots who were flying at the time, the pilot of the ZS-PXI aircraft had transmitted a Mayday call on the VHF 125.80 MHz.

3.2.17 The PIC of the ZS-CPL had informed ATC at FALA on VHF 124.00 MHz about the Mayday call that was broadcasted by the ZS-PXI aircraft.

3.2.18 According to the weight and balance for this flight, the aircraft had approximately 140 litres (37 US gallons) of fuel on-board prior to the flight.

The ZS-OMN aircraft

3.2.19 The aircraft was issued a Certificate of Airworthiness on 21 August 2003 with an expiry date of 31 August 2021.

3.2.20 The aircraft was issued a Certificate of Release to Service on 10 March 2021 with an expiry date of 9 March 2022 or at 15 455.4 airframe hours, whichever comes first.

3.2.21 The aircraft was issued a Certificate of Registration on 27 March 2013.

3.2.22 The last scheduled maintenance inspection carried out on the aircraft prior to the accident flight was certified on 10 March 2021 at 15 355.4 airframe hours. The aircraft had accumulated an additional 76.1 airframe hours since the said inspection.

3.2.23 The aircraft was refuelled to capacity prior to the flight, and 61 litres of Avgas was uplifted.

3.2.24 The aircraft was consumed by post-impact fuel-fed fire, however, the empennage section and the outer sections of the two wings sustained minor to no fire damage.

3.2.25 It was noted that the left vertical stabiliser and the elevator had separated from the aircraft and were located approximately 155m from the main wreckage of the ZS-OMN aircraft.

Environment

3.2.26 Fine weather conditions prevailed at the time of the accident, and the moon was full. According to the pilots of the ZS-KBW and ZS-STX aircraft, visibility was good in the Johannesburg flying training area at the time.

3.2.27 The collision occurred during nighttime in an uncontrolled airspace, while visual meteorological conditions (VMC) prevailed.

Aviation Training Organisations (ATO)

3.2.28 Both ATOs were in possession of valid SACAA-issued ATO certificates, and both training flights were duly authorised in line with both ATO procedures.

Aeronautical Information Publication (AIP)

3.2.29 AIP ENR 5.1-30 provides clear guidance to all aviators using the Johannesburg flying training area (FAD 182) on the applicable VHF frequency to be used when flying below an altitude of 7 600ft.

3.3. Probable Cause

3.3.1 The ZS-PXI and ZS-OMN aircraft collided mid-air while flying in FAD 182, and subsequently crashed on the ground.

3.4 Contributing factors

3.4.1 The ZS-PXI aircraft was not on the designated VHF for FAD 182; therefore, the other traffic in the vicinity was not aware of its presence. Even if both crews had broadcasted their intentions at the time leading to the collision, they would have been unable to ensure adequate separation because they were not on the same frequency; therefore, they would have not heard each other.

3.4.2 The flight path data does not indicate either of the aircraft initiated an evasive manoeuvre, which suggests that the pilots of both aircraft had no visual of each other, and hence, could not take action to avoid the collision.

4. SAFETY RECOMMENDATIONS

4.1. 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.

4.2. Safety Recommendations

4.2.1 Aircraft external lighting is critical to operational safety; hence, it is recommended that aircraft, especially those that are used in the training environment, be equipped with the latest technology to ensure visibility is enhanced under all flying conditions — by day or night. Technology in the field of aircraft lighting has developed tremendously since these aircraft first started flying in the 1960s, 1970s and 1980s. It is, therefore, essential that ATOs ensure the aircraft used in the training environment are as visible as possible to avoid any possible mid-air collisions.

4.2.2 It is recommended that all aircraft flying in FAD 182 or any other flying training area in the country at night switch on the landing lights. Although the landing lights have a relatively narrow beam and may be visible from the frontal aspect of an aircraft, they could avoid a possible mid-air collision.

4.2.3 It is recommended that IFR training by night be moved from uncontrolled airspace to controlled airspace where it will be more safely managed. It is, therefore, recommended that Air Traffic Navigational Services (ATNS) consider making provisions for training flights using very high frequency omni-directional range (VOR), instrument landing system (ILS) facilities and Area Navigation (RNAV) approaches at night at controlled airports.

4.2.4 ATOs are encouraged to ensure proper flight planning and regular communication/position reporting outside controlled airspaces to enhance safety awareness and separation of traffic in congested airspaces. It is recommended that CAA emphasise the importance of correct frequencies during their instructor and designated flight examiner (DFE) safety seminars.

4.3 Safety Messages

4.3.1 All flight instructors and pilots engaged in training under the provisions of an ATO and making use of the Johannesburg flying training area or any other designated flying training area be aware of the correct frequencies to use. Due to the substantial number of ATOs in the Gauteng area, high traffic volumes could be experienced within the same flying training area, during the day and at night. Communicating intentions on a regular basis whilst flying in these training areas should be of paramount importance to ensure that other traffic is aware of your presence.

4.3.2 ICAO Doc 9426 states: "*When flying outside an established ATS route network, position reports are normally expressed in latitude and longitude or by using the specific name codes of assigned or designated reporting points. Position reports are given at intervals of 5-, 10- or 20-degrees latitude or longitude, as regionally agreed, to provide information at approximately hourly intervals. This relatively low rate of position updates is one of the*

reasons for the comparatively large horizontal separation minima applied in oceanic airspace". Therefore, ATOs should emphasise through pilot training and examination programmes the importance of accurate position reporting. This is of extreme importance when flying in areas of high traffic volumes.

5. APPENDICES

5.1 Annexure A - (ENR 5.1-30, FAD 182 Johannesburg Flying Training Area)

5.2 Annexure B – (ENR 5.1-1, Prohibited, Restricted and Danger Areas)

This report is issued by:
Accident and Incident Investigations Division
South African Civil Aviation Authority
Republic of South Africa

ANNEXURE A

Identification and Name *Lateral Limits*	*Upper Limit* *Lower Limit*	*Type of hazard or Restriction*	*Remarks*	*Controlling authority*
FAD 170 TZANEEN FLYING TRAINING AREA				
(a) From a point at 234300S 0301400E, NE to a point at 233500S 0302700E (b) Thence SE along the Merekome river to the Letaba river to a point at 233800S 0303700E (c) Thence SW along the Letaba river to the Mwanedzi river to a point at 234500S 0302800E (d) Thence a straight line Westward to the starting point.	FL 90 GND			
FAD 182 JOHANNESBURG FLYING TRAINING AREA				
(a) From a point at 261800S 0274850E along the railway line to a point at 262600S 0275150E (b) Thence South Westwards along the road to a point at 263710S 0274650E (c) Thence Westwards along the road to a point at 263740S 0273030E (d) Thence Northwards along the road, via Fochville to a point at 262630S 0272900E (e) Thence North-Eastwards along the road to the starting point at 261800S 0274850E	FL100 GND		Excluding the area under the Johannesburg TMA where the upper limit of FAD 182 will be 7600 FT ALT. Communication FREQ: 122.35MHz	
FAD 183 JOHANNESBURG HELICOPTER GENERAL FLYING AREA				
Lateral limits -The area bounded by lines drawn as follows: (a) From the road intersection at a point at 261900S 0280350E, Westwards along the road to a point at 261930S 0280000E (b) Thence a straight line to a point at 262800S 0280000E (c) Thence along the road in a South-Easterly direction to a point at 262920S 0280330E (d) Thence Northwards along the R26 to a point at 262100S 0280600E (e) Thence North-Westwards along the road to the road to the starting point at 261900S 0280350E.	6500 FT ALT GND		FREQ: 124.4MHz	

ANNEXURE B

ENR 5 NAVIGATION WARNINGS
ENR 5.1 PROHIBITED, RESTRICTED AND DANGER AREAS

1 Prohibited, restricted and danger areas.

All airspaces in which a potential hazard to aircraft operations exist and all areas over which the operation of civil aircraft are restricted or prohibited are classified according to the following three types of areas as defined by ICAO:-

1.1 DANGER AREA

An airspace of defined dimensions within which activities dangerous to the flight of aircraft may exist at specified times. This term is used only when the potential danger to aircraft has not led to the designation of the airspace as restricted or prohibited. The effect of the danger area is to caution operators or pilots of aircraft that it is necessary for them to assess the dangers in relation to their responsibility for the safety of their aircraft.

1.2 PROHIBITED AREA

An airspace of defined dimensions, above the land areas or territorial waters of a State, within which the flight of civil aircraft within the designated airspace is not permitted at any time under any circumstances.

1.3 RESTRICTED AREA

An airspace of defined dimensions, above the land areas or territorial waters of a State, within which the flight of aircraft is restricted in accordance with certain specified conditions. This term is used whenever the flight of civil aircraft within the designated airspace is not absolutely prohibited but may be made only if specified conditions are complied with. Thus, prohibition of flight except at certain specified times leads to the designation of the airspace a "restricted area" as would prohibition except in certain meteorological conditions. Similarly, prohibition of flight unless special permission had been obtained, leads to the designation of a restricted area. However conditions of flight imposed as a result of application of rules of the air or air traffic service practices or procedures (for example, compliance with minimum safe heights or with rules stemming from the establishment of controlled airspace) do not constitute calling for designation as a restricted area. Each area is numbered and a single series of numbers is used for all areas, regardless of type, to ensure that a number is never duplicated.

The type of area involved is indicated by the letter "P" for prohibited area. "R" for restricted areas and "D" for danger areas, preceded by the nationality letters "FA", e.g. FAP1, FAD2, FAD3, FAP4, FAR5, FAD6, e.t.c.

Each area is described in the tabulations below which indicates its lateral and vertical limits, the type of restriction or hazard involved, the times at which it applies and other pertinent information.