The South African Civil Aviation Authority

Aircraft Accident Investigation

Final Report

Cessna S550 (ZS-CAR)

George Aerodrome (FAGG) January 23, 2020

AIID Ref No: CA18/2/3/9855
November, 2021

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AIRCRAFT ACCIDENT INVESTIGATION BUREAU

ቀን 16-11-2021
Date
ቁጥር APIB/17/14
Ref.

Ms. Patience Mabasa

National Department of Transport Civil Aviation Safety

Ministry of Transport

The Republic of South Africa

Johannesburg

Subject: **Aircraft Cessna S550, ZS-CAR Accident Final Investigation report**

Your, Excellency;

The Ethiopian Aircraft accident Investigation (AAIB) is grateful for the opportunity to investigate aircraft S550, ZSCAR accident occurred on 23 January, 2020 at 0853Z;

Enclosed herewith please find a soft copy of the final report of S550, registration ZSCAR. The accident aircraft impacted terrain while flying for calibration flight at FAGG. In regards to safety investigation and to enhance safety the Ethiopian AAIB cordially submits the final investigation report to your esteemed office as per the MOU signed between the South African AIID and Ethiopian AAIB.

The Ethiopian AAIB believes that this is the first step for both countries sharing significant benefits for common interest and a good example for other African countries for developing bilateral relations in the area of aircraft accident investigations.

Kind Regards

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I. FOREWORD

THE AIRCRAFT ACCIDENT INVESTIGATION BUREAU OF ETHIOPIA

The Aircraft Accident Investigation Bureau (AAIB) is the investigation authority in Ethiopia responsible to the Ministry of Transport for the investigation of civil Aircraft accidents and serious incidents in Ethiopia. The mission of the AAIB is to promote aviation safety through the conduct of independent, separate investigations without prejudice to any judicial or administrative action consistent with Annex 13 to the Convention on International Civil Aviation.

The AAIB conducts the investigations in accordance with the proclamation No 957/2016 and Annex 13 to the Convention on International Civil Aviation Organization, which governs how member States of the International Civil Aviation Organization (ICAO) conduct Aircraft accident investigations internationally.

The investigation process involves the gathering, recording and analysis of all available information on the accidents and incidents; determination of the causes and/or contributing factors; identification of safety issues; issuance of safety recommendations to address these safety issues; and completion of the investigation report. In carrying out the investigations, the AAIB will adhere to ICAO's stated objective, which is as follows:

"The sole objective of the investigation of an accident or incident shall be the prevention of accidents and incidents; it is not the purpose of this activity to apportion blame or liability''.

TABLE OF CONTENT

II. ORGANISATION OF THE INVESTIGATION

DELEGATION

This Agreement documents the delegation of the investigation of the ZS-CAR accident by AIID responsible to the Ministry of Transport of South African to the AAIB of Ethiopia, hereafter collectively referred to as "the Parties" (operational agreement of the delegation of Aircraft Accident investigation involving Aircraft Cessna 550S, ZS-CAR, MOU) see Attachment A.

It is recognized that both AIID and AAIB are Parties to the 1944 Convention on International Civil Aviation (the Chicago Convention) and are therefore bound by the Standards contained in Annex 13 — Aircraft Accident and Incident Investigations to the Chicago Convention.

Note. — Both States shall advise each other of their respective existing differences that have been filed or that will be filed against the Standards of Annex 13.

It is recognized that the South African AIID is a Party to the Convention on International Civil Aviation (the Chicago Convention) and the Ethiopian AAIB is established for conducting investigations under the provisions of Annex 13 — Aircraft Accident and Incident Investigation. Both Parties shall be bound by the Standards contained in Annex 13 to the Chicago Convention. This Agreement is in accordance with Annex 13 to the Chicago Convention, stated above.

Annex 13 Article, *5.1 The State of Occurrence shall institute an investigation into the circumstances of the accident and be responsible for the conduct of the investigation, but it may delegate the whole or any part of the conducting of such investigation to another State or a regional accident and incident investigation organization (RAIO) by mutual arrangement and consent. In any event, the State of Occurrence shall use every means to facilitate the investigation.*

> ***Recommendation—*** *the State of Occurrence should institute an investigation into the circumstances of a serious incident. Such a State may delegate the whole or any part of the conducting of such investigation to another State or a regional accident and incident investigation organization by mutual arrangement and consent. In any event the State of Occurrence should use every means to facilitate the investigation.*
>
> *The State of Occurrence shall institute an investigation into the circumstances of a serious incident when the aircraft is of a maximum mass of over 2250 kg. Such a State may delegate the whole or any part of the conducting of such investigation to another State or a regional accident and incident investigation organization by mutual arrangement and consent. In any event the State of Occurrence shall use every means to facilitate the investigation.*

Note 1— The investigation of a serious incident does not exclude other already existing types of investigation of incidents (serious or not) by other organizations.

Note 2— When the whole investigation is delegated to another State or a regional accident and incident investigation organization, such a State is expected to be responsible for the conduct of the investigation, including the issuance of the Final Report and the ADREP reporting. When a part of the investigation is delegated, the State of Occurrence usually retains the responsibility for the conduct of the investigation.

PURPOSE OF THE INVESTIGATION

According to AAIB Rules and Standards Article 3.1 and the South African AIID Regulation 12.03.1 the sole objective of the investigation of an accident or serious incident shall be the prevention of accidents and serious incidents. It is not the purpose of this activity to apportion blame or liability.

III. INVESTIGATION PROCESS

The Ministry of Transport of the Federal Democratic republic of Ethiopia accepted the request from South African Ministry of Transport for assistance referring the Article 26 of the Convention on International Civil Aviation (Chicago Convention) and according to Annex 13 article 5.1 to the Convention.

The Ministry of Transport of the Federal Democratic Republic of Ethiopia ordered the AAIB to conduct investigation on ZSCAR aircraft in terms of AAIB ACT 2016 (Act No. 957/2016)

The Ethiopian AAIB invited by the South African AIID to conduct aircraft accident investigation of ZS-CAR on behalf of South African AIID.

The South African recognized that both AIID and AAIB are parties to the 1944 convention on International Civil Aviation (the Chicago Convention) and are therefore bound by the standards contained in Annex 13- Aircraft Accident and incident Investigations to the Chicago Convention.

The South African AIID is a party to the Convention on International Civil Aviation (the Chicago Convention) and the Ethiopian AAIB is established for conducting under the provision of Annex 13 Aircraft Accident and incident Investigation.

The AAIB appointed Investigator in Charge with team members to travel to South Africa and takeover the investigation from AIID. The AAIB shall confer entitlement to represent the AIID in all aspects of the investigation under the control of the investigator-in-change, in particular to:

a. visit the scene of the accident
b. examine the wreckage
c. obtain witness information and suggest areas of questioning
d. have full access to all relevant evidence
e. receive copies of all pertinent documents
f. Participate in off-scene investigative activities such as component examinations, technicalbriefings, tests and simulations as required.
g. participate in investigation progress meetings including deliberations related to analysis,findings, causes, contributing factors and safety recommendations
h. make submissions in respect of the various elements of the investigation

The AAIB will submit the final draft report to AIID for comments then after when the two parties come to agreement the final report will be released to the public with consent of the South African AIID.

Notes:

1. *Whenever the following words are mentioned in this report, they shall mean the following:*

   - *Accident – this investigated accident*
   - *Aircraft – the Cessna S550 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 obtained 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 color, brightness, contrast; or addition of text boxes, arrows or lines.*

3. *The aircraft Accident and Incident Investigations Division (AIID) is a division within the South African Civil Aviation Authority tasked with independent function of investigating aircraft accidents and incidents in South Africa on behalf of the Department of Transport. The division reports administratively to the Director of Civil Aviation and functionally to the Minister of Transport through the Deputy Director General: Civil Aviation.*

4. *The Flight Inspection Unit (FIU) is a Division within the SACAA responsible for calibration of aerodrome navigation and approach facilities for commercial purposes. In this report, the FIU Division unit under the SACAA will be regarded as the operator.*

Disclaimer:

ACRONYMS

AMM	Aircraft Maintenance Manual
AC	Approach Controller
AFM	Aircraft Approved Flight Manual
AGL	Above Ground Level
AIID	Accident Incident Investigation Division
AMO	Aircraft Maintenance Organization
AMSL	Above Mean Sea Level
AOC	Air Operating Certificate
APP	Approach Controller Officer
ARCC	Aeronautical Rescue Coordination Centre
ARFF	Aircraft Rescue and Fire-Fighting
ATC	Air Traffic Control
ATNS	Air Traffic And Navigation Service
ATPL	Airline Transport Pilot License
BEA	Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile
C of A	Certificate of Airworthiness
C of R	Certificate of Registration
CAR	Civil Aviation Regulation
CATS	Civil Aviation Technical Standards
CAVOK	Ceiling and Visibility OK
CPL	Commercial Pilot License
CTR	Controlled Airspace
CVOR	Cumulated VOR
CVR	Cockpit Voice Recorder
DME	Distance Measuring Equipment
DOT	Department Of Transport
DVOR	Doppler(Direct) VOR
ELT	Emergency Locator Transmitter
FAGG	George Aerodrome, Western Cape
FAOR	OR Tambo International
FAPE	Port Elizabeth Aerodrome, Eastern Cape
FAPE	Port Elizabeth Aerodrome
FAWB	Wonder Boom Aerodrome
FCCSU	Flash Crash Survivable Storage Unit
FCSSU	Flash Crash Survivable Storage Unit
FDR	Flight Data Recorder
FFS	Full Flight Simulator
FIU	Flight Inspection Unit
FL	Flight Level
FMS	Flight Management System

FO	First Officer
FSTD	Flight Simulation Training Device
FSTD	Flight Simulation Training Device
GNSS	Global Navigation Satellite System
GP	Ground Proximity
GPS	Global Positioning System
GRV VOR	George VOR
HPA	Hecto Pascal
HSI	Hot Section Inspection
ICAO	International Civil Aviation Organization
IFR	Instrument Flying Rules
IIC	Investigator-in-Charge
ILS	Instrument Landing System
KT	Knot
METAR	Metrological Aeronautical Radio Code For Routine Report
MHz	Megahertz
MOU	Memorandum OF Understanding
MSA	Minimum Safe Altitude
NAV	Navigation
NM	Nautical Mile
OM	Operation And Maintenance(Organizational Maintenance)
PAPI	Precision Approach Path Indicator
PCB	Printed Circuit Board
PIC	Pilot-In-Command
POH	Pilot Operational Handbook
PPC	Pilot proficiency Check
QNH	Query: Nautical Height
RAIO	Regional Accident And Incident Investigation Organization
SACAA	South Africa Civil Aviation Authority
SACAR	South African Civil Aviation Regulations, 2011
SACAT	South African Civil Aviation Technical Standards, 2011
SAWS	South African Weather Service
SOP	Standard Operational Procedure
TACAN	Tactical Air Navigation
TAWS	Terrain Avoidance Warning System
TAWS	Terrain Awareness Warning System
TCC	Cumulated Time
TMA	Terminal Maneuvering Area
TSO	Time Since Overhauled
TWR	Tower
VFR	Visual Flight Rules
VHF	Very High Frequency

VMC	Visual Metrological condition
VOR	VHF Omni directional Range
Z	Zulu

IV. DESCRIPTION OF THE ACCIDENT

Reference Number CA18/2/3/9855

Name of Owner..... South African Civil Aviation Authority

Name of the Operator.....South African Civil Aviation Authority

Manufacturer.....Cessna Aircraft Company

Model.....S550

Nationality… .....South African

Registration Marks… ..... ZS-CAR

Place.....George Aerodrome (FAGG)

Date ..... 23 January 2020

Time 0853Z

All times given in this report is Co-ordinate Universal Time (UTC) and will be denoted by (Z). South African Standard Time is UTC plus 2 hours. All altitudes in this report are mean sea level unless otherwise indicated.

1. FACTUAL INFORMATION

1.1. HISTORY OF THE FLIGHT

On Thursday morning, 23 January 2020, the Cessna S550 with registration ZS-CAR departed Port Elizabeth Aerodrome (FAPE) on a positioning flight to George Aerodrome (FAGG). On approach to FAGG, the flying crew requested to carry out a calibration flight for the very high frequency Omni directional range (VOR) beacon at FAGG. But, due to inclement weather conditions at the time, they were not cleared to conduct VOR calibration. As a result they decided to land and refuel the aircraft and commence the calibration of the Instrument Landing System (ILS) on Runway RWY 11 at FAGG.

At 08:24:07 the Technician (flight inspector on board) through intercom advised the crew to request the ATC (FAGG) instead of a calibration flight for the very high frequency Omni directional range (VOR) beacon at FAGG ZS-CAR will execute the ILS RWY 11 for calibration.

At 08:28:25 the first officer with call sign ZS-CAR requested star up for ILS calibration they are three onboard, for advised that there are 3 people on board, for 4:30min endurance, and at 3000ft;

At 08:28:32 ATC at FAGG approved for RWY 11 on QNH of 1018;

At 08:28:44 the first officer confirmed that they are cleared to start up for ILS calibration at3000ft RWY11 QNH 1018, and requested to intercept radial 250 and fly the 17 DME clockwise arc from radial 250 up to radial 330;

At 08:32:25 TWR discussed the request with APP that the possibility of declaring VMC as the weather minima within the legal limit to perform calibration;

At 08:39:35 The first officer requested take-off from RWY 11 and an early right turn to intercept radial 250°, 17 nautical miles (nm) Distance Measuring Equipment (DME) arc to radial 330° at 3000 feet (ft) climbing to 4000ft and the air traffic control (ATC) approved their request;

At 08:40:04 the first officer acknowledged that the ZSCAR is flying on 250^0 radial with an altitude 3000ft and this was confirmed by the ATC;

At 08:40:22 the ZSCAR was ready for takeoff from FAGG, at 08:40:27 the ATC advised that RWY 11 surface wind is 120degrees 15knts;

At 08:42 the aircraft was airborne. Radar data indicated that the aircraft took off from RWY 11 and, once airborne, made a right turns to intercept radial 250° using the George VOR (GRV VOR). The aircraft climbed to 3000ft. Once the aircraft reached 17NM on the DME from the GRV VOR (DME is co-located with the VOR), it commenced with a right-hand turn to intercept radial 330° while maintaining 17NM DME arc;

At 08:44:01the first officer advised that they are flying to the threshold and break towards the coast and position to fly about 10 times;

At 08:44:25 APP controller (composite) briefed the TWR controller on ZSCAR's intentions for the rest of the calibrations for RWY 11;

At 08:44:48 ZSRx1 called APP to advise that he is airborne and routing west bound to clear CTR;

At 08:46:10 the ATC gave advice that ZSCAR will be outside the TMA, and to broadcast 124.2 for traffic below the TMA;

At 08:50:31ZSCAR commenced right turn appeared to level off at 4000ft, and at 08:50:50 the radar showed that ZSCAR started climbing;

At 00:20:15-00:21 FDR time the Aircraft pitch decreased from 5^0 degrees to two degrees with an increase of its speed to 245kts at the same time the altitude increased from 2900ft to 3900ft.

At 00:20:45 FDR time the aircraft roll was about zero degrees and began to increase to 35 degrees; even though the aircraft magnetic heading was constant (37.5^0);

At 00:21-00:21:10 FDR time the aircraft was flying with nose down to -32.5 degrees decreasing its altitude to 3200ft and 2800ft. The aircraft heading changed to 150degrees and its roll to 105 degrees which was overbanked and immediately changed to 75^0; the roll of the aircraft suddenly changed from 35 to 105 degrees and then to 75^0.

At 00:21:10-21:13 FDR time the aircraft was nose down, altitude, speed and roll decreased as it is indicated on the graph. The altitude of the aircraft was at lower level as it was compared with the surrounding and its pitch was nose down (-17.5^0)

At 08:51:41 radar target started to disappear and at 08:51:59 radar target completely disappeared (FPL track only);

At 08:52:29 APP stated that ZSCAR disappeared from radar and called many times saying CAR Approach; at 08:55:38 TWR was heard that in the back ground stating that nothing heard through 124.2, 124.8 and 121.5;

After loss of contact with the aircraft, an emergency was declared and an official search and rescue operation was instituted;

The crash site found at the top of the Outeniqua mountains, near the town of Friemersheim, at Global Positioning System (GPS) co-ordinates 33°55'24" South 022°06'30" East, at an elevation of 2192ft. The aircraft was found destroyed on impact and all occupants were fatally injury.

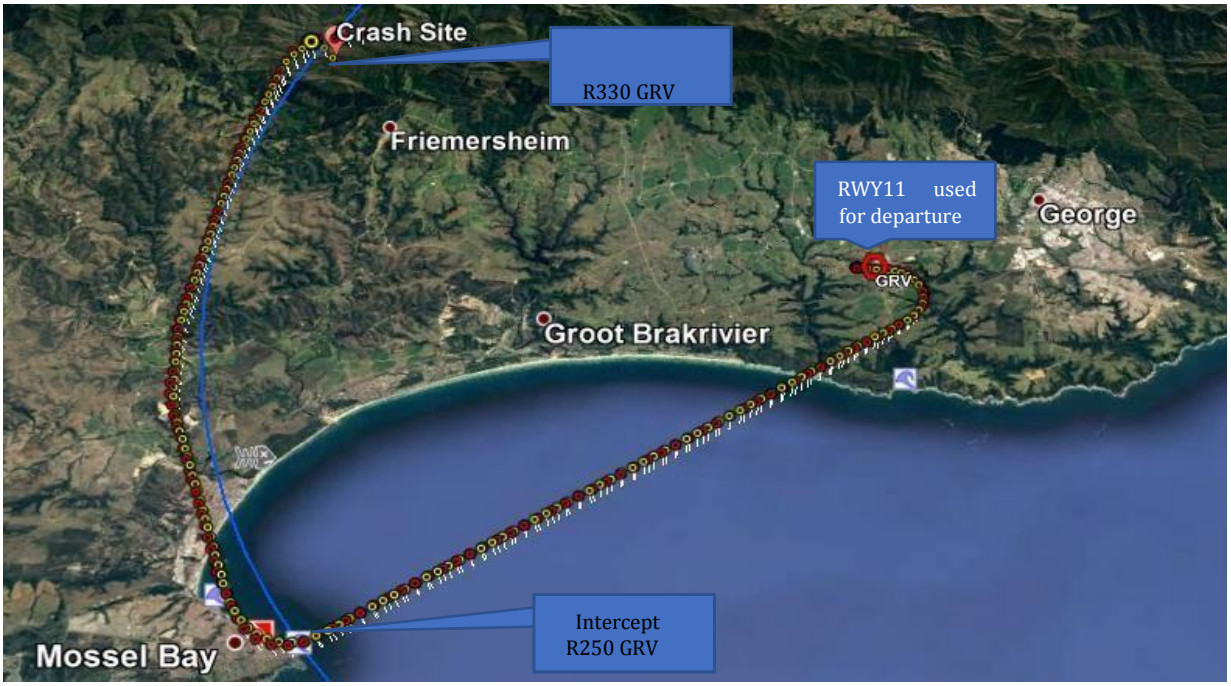


Figure 1: The routing of the aircraft prior to impact based on radar data (Source: Google Earth and ATNS)

Figure 2: The wreckage was located north of Friemersheim in the Western Cape. (Source: Google Earth)

1.2 INJURIES TO PERSONS

Table: 1 injury to person

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

1.3 DAMAGE TO AIRCRAFT

The aircraft was destroyed.

1.4 OTHER DAMAGE

No other damage.

1.5 PERSONNEL INFORMATION

1.5.1 Pilot-In-Command (PIC)

Table: 2 PIC information

Nationality	South African	Gender	Male	Age	49
License Type	ATPL				
License Valid	Yes	Type Endorsed	Yes		
Ratings	Instrument, Instructor Grade 2				
Medical Expiry Date	31 October 2020				
Restrictions	Corrective Lenses				
Previous Accidents	None				
Proficiency check expiry date	07 May, 2020				

Flying Experience

Total Hours	5215.4
Total Past 90 Days	15.4
Total on Type Past 90 Days	15.4
Total on Type	1315.4

The PIC had been issued with a class 1 aviation medical certificate on 23 October 2019 with an expiry date of 31 October 2020. The PIC had flown approximately 20 hours of flight calibration of navigational aids at FAGG. The above flying hour has indicated that the PIC was not new for FAGG and he was qualified to execute calibration flight on the mentioned aerodrome.

Proficiency Check of PIC

The operation manual of FIU has been prepared in accordance with the South African Civil Aviation regulation, 2011 and complies with all applicable and duly promulgated South African Civil Aviation regulations and terms and condition of the FIU operating certificate.

The operation manual contains four main parts as described in detail. The fourth part is training manual; this part comprises all training instructions for personnel required for a safe operations.

a) In part four section 1.5.1 of the operation manual (six monthly) operator proficiency checks in accordance with the SA –CARS 135..03.7 is stated as:
    1. Each flight deck crew member undergoes such checks to demonstrate his or her competence in carrying out normal abnormal and emergency procedures every six months and
    2. Such check is conducted without external visual reference when the flight deck crew number will be required to operate under IFR;
    3. Upon successful completion of the operator proficiency check, FIU shall issue a certificate of competency to the flight deck crew members concerned, which certificate shall be valid for a period of six calendar months calculated from last day of the calendar month in which such certificate is issued.

b) In the South African Civil Aviation regulation 2011, part 135.03.6(3) (a) the validity period for flight crew members is stated as follows:

i) Except as provided in subparagraph (ii),

A PPC or competency check is valid to the first day of the seventh month following the PPC or competency check took place. PIC carried out his proficiency check on 31 May, 2019 which was valid for six calendar months and to expire on 07 May, 2020.

But during referring PIC documents, the PIC carried out his proficiency check on 31 May, 2019 which was valid for six calendar months and was to expire on 30 November, 2019; this shows that the Pilot Proficiency Check expired before the accident. Instead of PPC it was incorporated with the current training document submitted by SACAA that the PIC conducted on 08 Nov 2019 which will expire on May 7, 2020.

The PIC conducted training at flight safety Textron aviation training on 08 Nov 2019 and issued a certificate for completing the training. In the flight safety Textron aviation training syllabus PPC contents are listed, However, there is no graded and confirmed by signed grade slip evidence that

PIC performed the PPC training contents either with an aircraft or a simulator according to flight operations PPC standards.

The unusual attitude recovery training included in the syllabus, due to the nature of the training it has always been done on the simulator and covered by the flight simulator training, however, on this training course the Flight Safety Textron aviation only issued course syllabus and certificate for conducting the training, there is no graded evidence that show the PIC performed unusual attitude recovery training on simulator.

1.5.2 First Officer (FO)

Table: 3 FO Information

Nationality	South African	Gender	Female	Age	33
License Type	CPL				
License Valid	Yes	Type Endorsed	Yes		
Ratings	Instrument				
Medical Expiry Date	31 July 2020				
Restrictions	None				
Previous Accidents	None				
Proficiency check expiry date	31 March, 2020				

Flying Experience

Total Hours	1061.8
Total Past 90 Days	15.4
Total on Type Past 90 Days	15.4
Total on Type	265.9

The FO had been issued with a class 1 aviation medical certificate on 26 September 2019 with an expirydate of 31 July 2020.

Before the accident, the FO had completed approximately two hours of flight calibration of navigational aids at FAGG. As a crew pairing, the PIC and FO had completed approximately 200 hours of flight calibration of navigational aids. This included 58 VOR and 50 ILS calibrations.

The Flight Inspection Unit (FIU) inspector operated the flight inspection system (CARNAC-30) on-boardthe aircraft which was used to calibrate navigational and approach facilities.

1.5.3 Air Traffic Controller (ATC):

Table4: ATC Information

Nationality	South African	Gender	Female	Age	44
License Type	Aerodrome Control Air Traffic Services				
License Valid	Yes	Unit Endorsed	Yes		
Ratings	Instructor Grade 1, Aerodrome Control				
Medical Expiry Date	28 February 2020				
Restrictions	None				
Previous Accidents	None				

The ATC had first been issued a license on 28 February 2003. The ATC has taken ratings on: AD, Area, Area/SURV/ATSA, ATSA/CLD/ATSA/Coord and FIS.

The ATC had been issued a level 6 language proficiency certificate on 28 March 2007.

The ATC had been issued with a class 3 aviation medical certificate on 19 February 2018 with an expiry date of 28 February 2020.

The ATC's last aerodrome proficiency checks for FAGG and FAOR were carried out on 14 August 2019 and 8 July 2019, respectively. Both licenses were issued with the expiry dates of 13 June 2020 and 7 January 2020, respectively. Her license for FAGG was valid at the time of the accident however; the FAORlicense had expired as per the dates above.

1.5.4 Approach Controller (AC):

Table: 5 AC Information

Nationality	South African	Gender	Female	Age	31
License Type	Aerodrome Control Air Traffic Services				
License Valid	Yes	Unit Endorsed	Yes		
Ratings	Instructor Grade 2, Aerodrome Approach Control Procedures and Approach Control Surveillance.				
Medical Expiry Date	31 March 2020				
Restrictions	None				
Previous Accidents	None				

The AC had first been issued a license on 24 August 2007. The AC had the following ratings: AD, APP, APP/SURV/ATSA, ATSA/CLD/ATSA/Coord and ATSA/FIS.

The AC had been issued a level 6 language proficiency certificate on 20 August 2007.

The AC had been issued with a class 1 aviation medical certificate on 12 March 2019 with an expiry date of 31 March 2023.

The AC's last proficiency check for aerodrome control was carried out at FAGG on 5 December 2019and the license was issued on the same day with an expiry date of 4 December 2020. The AC also

had the approach control procedure proficiency check carried out on 7 May 2019; and the competency license was issued on the same day with an expiry date of 6 May 2020. The AC also had the surveillance proficiency check for FAGG carried out on 26 April 2019; and the license was issued on the same day with an expiry date of 25 April 2020.

1.6 AIRCRAFT INFORMATION

The accident aircraft was a Cessna S550 which was manufactured in 1986. The aircraft was fitted with two Pratt and Whitney Canada JT15D-4B turbo fan engines. The aircraft was used by the FIU to calibrate navigational and approach facilities. It was fitted with additional equipment (CARNAC-30) in the passenger compartment to allow the inspector on-board to carry out the calibration function.

The aircraft was issued the initial Certificate of Airworthiness on 26 October, 1986; the last Certificate of Airworthiness was reissued on 29 October 2019, with an expiry date of 30 October 2020. Due to none compliance with Civil Aviation Regulations Part 43 requirements, the aircraft Certificate of Airworthiness was rendered invalid at the time of the accident in accordance with the following:

CAR Part 21.08.12 *(1) A certificate of airworthiness shall, subject to sub-regulation (2), be valid for a period of 12 months or until it is surrendered by the holder thereof, or is suspended by an authorized officer, inspector or authorized person, or cancelled by the Director.*

(2) Notwithstanding the provisions of sub-regulation (1), a certificate of airworthiness shall be rendered invalid if—

(a) the aircraft is removed from a South African aircraft register

(b) The aircraft is not maintained in accordance with the regulations prescribed in Part 43;

The last weight and balance check was done on 13 Oct 2015. The aircraft was used by the FIU of South Africa civil aviation to calibrate navigational and approach facilities.

1.6.1 Airframe

Table 6: Airframe Information

Type	Cessna S550	
Serial Number	S550-0078	
Manufacturer	Cessna Aircraft Company	
Date of Manufacture	1986	
Total Airframe Hours (At time of Accident)	10106.1	
Last Inspection (Date & Hours)	13 August 2019	10031.1
Hours since Last Inspection	75	
C of A (Issue Date)	28 October 1986	
C of A (Expiry Date)	30 October 2020	
C of R (Issue Date) (Present owner)	26 August 2010	
Operating Categories	Part 135 (Air Transport Operations) and Part 171 (Flight Calibration of Navigational Equipment).	

The first owner of the aircraft was with the Department of Transport (DoT) of the Republic of South Africa (RSA). The ownership was then transferred to the SACAA after its establishment on 1 October, 1998.

Major Aircraft Defects and Damages Based on the Aircraft Maintenance Records:

- On 30 March 1988 at 351.20 hours, the aircraft was repaired following an incident which resulted in both wings being wrinkled forward of the main spar and stab wing;
- On 20 October 1993 at 1284.45 hours, the aircraft was damaged by a hail storm whilst on approach for the then Jan Smuts Airport, now O.R. Tambo International Airport.
- On 7 November 2019, the aircraft was on approach for Wonder Boom Aerodrome (FAWB) when the flying crew experienced an oil smell and smoke in the cockpit; the AMO carried out maintenance to rectify the defect and, following the maintenance, the aircraft was released to service.
- On 8 November 2019 during the take-off roll, the crew experienced smoke in the cockpit. The crew decided to abort take-off, and the aircraft was taxied back to the hanger before the engines were shut down. The AMO further investigated the incident and found out that there was a seal leaking in the engine and that resulted in the AMO replacing the defective engine.

Records of the airframe indicated that on 22 March 1994, the aircraft was fitted with two Pratt & Whitney JT15D-4B engines with serial numbers 102187 and 102175.

Records of the airframe logbook further indicated that on 13 May 2011 at 7032.6 hours, the left engine with serial number 102187 was removed for overhaul and replaced with an overhauled engine with serial number 102175, which was originally fitted on the right- hand side of the aircraft.

Following the overhaul of the left engine with serial number 102187, the engine was fitted on the right- hand side of the aircraft on 15 September 2011 with a total time of 7032.6hrs

1.6.2 Type of ELT Installed on the Aircraft (ARTEX C406-2)

The aircraft was fixed with an Emergency Locator Transmitter (ELT) with the description ARTEX ELT C406-2 with part number 453-5000 and serial number 170-07269. The ELT did not transmit a signal following the accident, and it was not found at the accident site. The ELT was last bench-checked on 28 May 2019 and its battery changed on 2 October 2019.

The ARTEX C406-2HM is an emergency locator transmitter (ELT) it transmits on all 3 emergency frequencies (121.5/243.0 and 406 MHz.). The ELT automatically activates during a crash and transmits the standard swept tone on 121.5 and 243.0 MHz it also transmits a 406 MHz encoded digital message to the COSPAS/SARSAT satellite system, which allows first responders to quickly and accurately identify not only where you are, but who you are as well, and reduces Search and Rescue response time and allow local first responders to more easily bring you home.

The C406-2 has been tested to meet the rigorous requirements of TSO C126, and pass even the toughestsafety tests including 500 G shock, 1000 pound crush as well as flame and vibration tests. The C406-2 isavailable for use with ARTEX's low cost whip antennas, rod antenna, or a blade antenna and may be interfaced with the optional ARTEX ELT/NAV Interface enabling latitude and longitude data to be transmitted as part of the 406 MHz message. The C406-2 uses two coax cables to accommodate all threefrequencies. The C406-2 ELT is available for fixed wing with a single-directional G-Switch.

FIGURE 3: ELT ARTEX C406-2

In accidents where ELTs may not work effectively (or at all) their performance could be affected by:

- Damage and/or removal of the antenna during impact
- Not selecting the ELT activation to armed before flight
- Incorrect installation
- Flat batteries
- Lack of water proofing
- Lack of fire protection
- Disconnection of the co-axial antenna cable from the unit during impact
- An aircraft coming to rest inverted after impact.

Another concern related to ELTs is that their batteries might cause fires this issue has begun to affect aircraft type certification of ELTs.

1.6.3 Engines

The Pratt & Whitney Canada JT15D-4B is a small turbofan engine built by Pratt & Whitney Canada. It was introduced in 1971 at 2,200lbf (9,800 N) thrust, and has since undergone a series of upgrades to just over 3,000lbf (13kN) thrust in the latest versions. It is the primary power plant for a wide variety

ofsmaller jet aircraft, notably business jets.

Figure: 4 Pratt & Whitney Canada JT15D-4B Engine

1.6.3.1 Engine No.1

Table 7: Engine No. 1

Type	JT15D-4B
Serial Number	PCE-102183
Hours since New	9290.5
Hours since Overhaul (modular assembly)	15.4 hours

The engine was overhauled on 19 January 2016 at 9275.1 hours. It had operated for 15.4 hours since installation on ZS-CAR on 16 January 2020.

History of engine No.1 changes:

- Removal and installation of Engine No 1 (left position):
- The first for hot section inspection (HSI)
- Removed twice and replaced with other similar engine

On 15 January 2020, at 10090airframe hours the number one engine (left engine) with serial number PCE:70925was replaced after 8 months in service at 8265.9 due to an oil leak caused by a labyrinth air seal resulting on an oil smell and smoke in the cockpit. The engine had accumulated a further 176.5 hours since the last overhaul.

1.6.3.2 Engine No.2

Table 8: Engine No. 2

Type	JT15D-4B
Serial Number	102187
Hours since New	9905.1
Hours since Overhaul	Modular assembly

Following the overhaul of the left engine on 31 August 2011 at 7032.6 hours, the engine was fitted on the number 2 (right side) engine position on 15 September 2011.

History of engine No.2 removal and installation:

- Engine No 2 (right position) was changed twice following scheduled engine overhaul.

1.7 METEOROLOGICAL INFORMATION

The weather information below was provided by the South African Weather Service (SAWS) for FAGG at 0900Z. The weather report of 23 January 2020 was obtained from the South African Weather Service (SAWS).

Table 9: Weather Data

Wind Direction	110°	Wind Speed	14kt	Visibility	9999m
Temperature	19°C	Cloud Cover	Broken	Cloud Base	2400ft
Dew Point	16°C	QNH	1018hPa		

According to the SAWS report "Significant clouds below 1,500ft above ground level (AGL) were present at the time of the accident as observed in the METARs. There was no indication of drasticwind direction or speed changes as seen on the spot graph. Mountain tops were obscured as seenon the webcam." Refer to Figure 5. Furthermore, no low-level turbulence was forecasted or observed in the area.

Figure 5: A Webcam Observation at 0829z in the morning of the accident at FAGG. (Source: SAWS)

1.8 AIDS TO NAVIGATION

The aircraft was equipped with standard navigational equipment as approved by the Regulator (SACAA) for the aircraft type. There was no record indicating that the navigation system was unserviceable prior to the flight.

The aircraft was equipped with a Terrain Avoidance Warning System (TAWS) which provides warning to the flying crew when coming close to terrain. However, due to regulation not requiring the installation of the cockpit voice recorder (CVR) on the accident aircraft, the investigation was unable to determine and no evidence found if TAWS was operational at the time of the accident.

The aircraft was equipped with standard communication equipment as per the equipment list approved by the Regulator. There were no recorded defects prior to the accident. No emergency calls were made to the FAGG ATC.

1.8.1 Instrument Landing System (ILS) Description

The ILS provides precision guidance to an aircraft during the final stages of the approach. The signals can either be interpreted by the pilot from the instruments or be input directly into the autopilot and flight management system. ILS performance is divided into three categories depending on the reliability, integrity and quality of guidance, with Category III having the strict requirements. An ILS comprises the following elements:

a) the localizer, operating in the frequency band from 108 to 112MHz, providing azimuth guidance to a typical maximum range of 46.3km (25nm) from the runway threshold;

b) the glide path, operating in the frequency band from 328 to 336MHz, providing elevationguidance to a typical maximum range of 18.5km (10nm) from the runway threshold; and

c) the marker beacons, operating on the frequency of 75MHz, providing position information atspecific distances from the runway threshold.

Note — on certain runways, a DME provides the distance information in place of marker beacons.

Source: ICAO Doc 8071, Chapter 4, Section 4.1.2

1.8.2 Very High Frequency Omni directional Radio Range (VOR) System Description

The VOR is a short-range radio navigation aid that produces an infinite number of bearings that may be visualized as lines radiating from the beacon. The number of bearings can be limited to 360, one degree apart, known as radials. A radial is identified by its magnetic bearing from the VOR.

The radials are generated in space by comparing the phase angle of two equal frequencies radiated from the beacon. One signal, called the reference, radiates Omni directionally so that its phase is equal in all directions. The second signal, called the variable, radiates from a directional array. The phase of the variable signal received at the aircraft is dependent upon the radial on which the receiver lies with respect to magnetic north.

Both signals are in-phase at magnetic north. The phase of the variable signals that of the reference signal by an amount equal to the azimuth angle around the beacon.

Source: ICAO Doc 8071, Chapter 2, Section 2.1.2 through 2.1.4

1.8.3 Distance Measuring Equipment (DME) System Description

The DME system provides continuous distance information to an aircraft during approach, departure or en-route procedures according to the location of the DME. The signals can be interpreted either by the pilot from the display or input directly into the flight management system (FMS*).*

Source: ICAO Doc 8071, Chapter 3, Section 3.1.2

1.9 COMMUNICATION

ATC Audio Transcript

Transcript of FAGG TWR voice recordings on 23/01/2020 regarding: ZSCAR

- Times in HH:MM:SS UTC/Z
- Station refers to any aircraft, ATC position or Vehicle making the transmission
- Text of transmission is the contents of the transmission for that specific time

Table: 10 ATC Transcripts

Time	Station	Text of Transmission	Comments
08:24:07	Intercom	Technician (flight inspector on board) phones to advise ATC thatthey will take the ILS (RWY 11) for calibration.	
08:27:48	ZSCAR	George Tower ZSCAR good morning (no response from ATC).	
08:28:06	ZSCAR(female voice)	George Tower ZSCAR good morning	
08:28:15	ATC	Last call to George Tower; report your call sign, go-ahead withyour transmission.	
08:28:19	ZSCAR(female voice)	It's ZSCAR, good morning ma'am.	
08:28:21	ATC	Morning CAR.	
08:28:25	ZSCAR(female voice)	Ma'am we are 3 on board, 4h30min of endurance, requestingstart for ILS calibrations, 3000 ft.	
08:28:32	ATC	CAR your start is approved ma'am for RWY11 on a QNH of 1018. Your transmission is slightly soft, I just want to verify you want to do the calibration and you want to intercept did you say 3000ft is that correct?	
08:28:44	ZSCAR(female voice)	Affirm ma'am, we would like to do the ILS calibration at 3000ft, RWY11 QNH1018, we are cleared start and we would like to intercept radial 250 and fly a 17 DME clockwise arc from radial 250 up to radial 330, CAR.	
08:29:05	ATC	CAR, ma'am, thanks for that information and I will be with youshortly for a clearance and a plan.	

Time	Station	Text of Transmission	Comments
08:32:00	Composite	TWR Controller then discusses the request with the APP Controller and advises that ZSCAR is now starting for the calibration. TWR then discusses the possibility of declaring VMCas the weather minima is within the legal limits to do this. VMC is declared at 08:32:25. They also have a discussion that the 17 DME arc is going to take the aircraft outside of controlled airspace and TWR must advise the pilot of this. The TWR Controller then asks if the APP Controller is happy with the clearance of RWY track climbing to 3000ft and she will advise the aircraft about the exiting of controlled airspace before she gets airborne. The TWR Controller has a brief discussion with the APP Controller about keeping the LSA sterile during calibrations	ZSRXI is in the CTR at this time.
08:35:47	ZSCAR(female voice)	TWR, CAR request taxi.	
08:35:50	ATC	CAR taxi via A, right on to A to the A1 holding point of RWY11.	
08:35:58	ZSCAR(female voice)	Right A, A1 holding RWY11, CAR.	
08:39:00	ZSCAR(female voice)	TWR, CAR ready to copy ATC clearance.	
08:39:04	ATC	Thank you CAR, after departure RWY11 climb maintain runway track to 3000ft, the approach control on 128.2 passing 2500ft squawk 1545.	
08:39:20	ZSCAR(female voice)	After departure RWY11 climb to 3000ft maintain runway trackand passing 2500ft, approach 128.2 squawk 1545, CAR.	
08:39:31	ATC	CAR read back is correct and report ready for departure.	
08:39:35	ZSCAR (female voice)	Report ready for departure next, CAR.	
08:39:37	ZSCAR (male voice)	And TWR, from CAR.	

08:39:39	ATC	Go ahead sir.	

Time	Station	Text of Transmission	Comments
08:39:41	ZSCAR(male voice)	Is it at all possible to do an immediate right turn (pause) after departure	
	Composite	TWR ATC passes on the pilots request to APP control – this is approved by APP	
08:39:52	ATC	CAR affirm, then you are re-cleared after departure RWY11 you can turn immediately right as per your request and then climbing to 3000ft, I just need to check are you then going out to intercept that radial as the lady said.	
08:40:04	ZSCAR (male voice)	Affirm ma'am, 250, 3000, immediate right turn 3000ft, CAR.	
08:40:08	ATC	CAR you're re-cleared affirm, your read back is correct, copied your intentions and then just a question with that 17, 17DME marker just to advise you you're going to be in and outside, just in and outside of controlled airspace for your planning.	
08:40:22	ZSCAR(male voice)	TWR copy that ma'am, CAR we're fully ready.	
08:40:27	ATC	CAR RWY11 surface wind is 120 degrees 15knts you are cleared for take-off and we'll chat to you later.	
08:42		ZSCAR airborne	
08:44:01	FO	advised that they are flying to the threshold and break towards the coast and position to fly about 10 times;	
08:44:25	APP	briefed the TWR controller on ZSCAR's intentions for the rest of the calibrations for RWY 11;	
08:44:48	ZSRx1	called APP to advise that he is airborne and routing west bound to clear CTR;	
08:46:10	ATC	gave advice that ZSCAR is outside the TMA, broadcast 124.2 for traffic below the TMA;	

1.9.1 Communication Failure Procedures

When FIU aircraft fails to establish contact with the aeronautical station on the designated frequency, it shall attempt to establish contact on another frequency appropriate to the route. If this attempt fails, the aircraft shall attempt to establish communication with other aircraft or other aeronautical stations on frequencies appropriate to the route. In addition, an aircraft shall monitor the appropriate VHF frequency for calls from nearby aircraft or aeronautical stations.

If this attempt fails, the aircraft station shall continue to transmit position reports and its intention as appropriate on the designated frequency or frequencies, preceded by the phrase "Transmitting Blind". Such messages shall be transmitted twice and, if necessary, include the addressee (s) for which the message is intended.

If no communication is received or other indication that one way communication are possible, the aircraft shall set its transponder to code 7600 and proceed with the lost communications procedures.

If the communication failure occurs while operating in accordance VFR, the FIU aircraft will continue to fly in visual meteorological conditions (VMC) and land at the nearest suitable aerodrome using _

a. the standard RCF arrival procedures prescribed in the manual (1.7.1.3) or

b. if other procedures have been published by the SACAA for a specific aerodrome, in accordance with such procedures in the AIP.

If the communications failure occurs while operating in accordance with IFR and VMC are encountered the FIU PIC shall:-

a. continue to fly in VMC; land at the nearest suitable aerodrome in accordance with –

i) the standard RCF arrival procedures prescribed in 1.7.1.3 or

ii) if other procedures have been published by the SACAA for a specific aerodrome, in accordance with such procedures in the AIP and

b. report its arrival by the most expeditious means to the appropriate ATSU; or

c. if unable to ensure VMC conditions exist to a suitable aerodrome, complete an IFR flight in accordance to the procedure.

1.10 AERODROME INFORMATION

Table 11: Aerodrome Information

Aerodrome Location	George, South Africa
Aerodrome Co-ordinates	S34°00'24.13" E022°22'27.41"
Aerodrome Elevation	648ft above mean sea level (AMSL)
Runway Designations	11/29
Runway Dimensions	2000m x 45m
Runway Used	11
Runway Surface	Asphalt
Approach Facilities	PAPI, VOR, ILS, DME, Runway lights
Aerodrome Status	Licensed

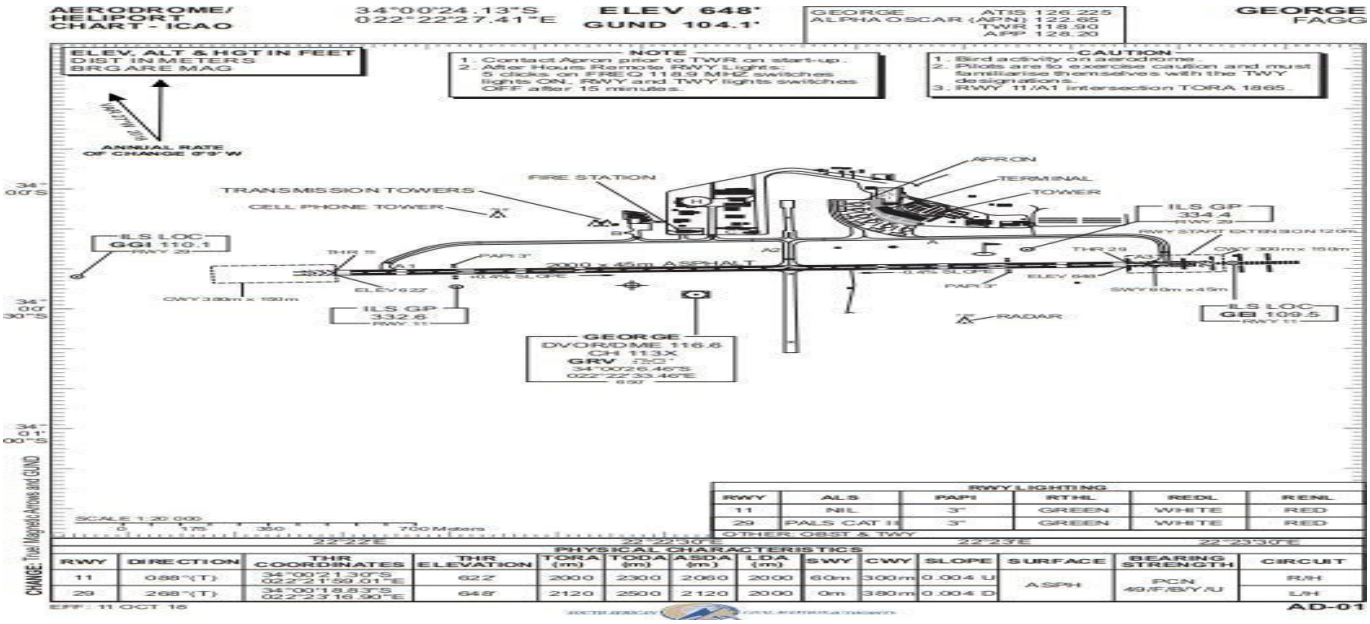


Figure 6: FAGG Aerodrome layout. (Source: SACAA)

1.11 FLIGHT RECORDERS

The aircraft was fitted with a Fairchild F-1000 Flight Data Recorder (FDR) as required by CAR 2011, Part 135.05.10. According to the documents received from the aircraft maintenance organization (AMO), the FDR was last tested and downloaded on 8 January 2018 by an approved AMO number 808. The South African Civil Aviation Technical Standards (SA-CATS) Part 135.05.9(4)(2)(a) requires an annual testing and downloading of the FDR to ensure that the recorded data from FDR operates correctly for the nominal duration of the recording.

The FDR was supposed to have been tested and downloaded on 8 January 2019 and only the test was conducted; therefore, the operator did not conduct an annual FDR download on 8 January 2020; as such, the operator was not in compliance with CAR Part 135.05.9 read together with SA-CATS 135.05.9 (4).

SA-CATS 135.05.9(4) Inspections of flight recorders

1. *Annual inspections shall be carried out as follows –*
    a. *the read-out of the recorded data from the FDR should confirm that the recorder operates correctly for the nominal duration of the recording;*
    b. *the analysis of the FDR should evaluate the quality of the recorded data to determine whether the bit error rate is within acceptable limits and to determine the nature and distribution of the errors;*
    c. *a complete flight from the FDR should be examined in engineering units to evaluate the validity of all recorded parameters. Particular attention should be given to parameters from sensors dedicated to the FDR. Parameters taken from the aircraft's electrical bus system need not be checked if their serviceability can be detected by other aircraft systems;*
2. *The results of the annual inspections shall be recorded and retained for a period of five years calculated from the date of such check.*
3. *Flight recorder systems should be considered unserviceable if there is a significant period of poor quality data, unintelligible signals or if one or more of the mandatory parameters is not recorded correctly.*
4. *When requested, a report of the annual inspection should be made available to the Director for monitoring purposes.*
5. *Calibration of the FDR-system –*
    a. *the FDR-system shall be recalibrated at least every five years to determine any discrepancies in the engineering conversion routines for the mandatory parameters and to ensure that parameters are being recorded within the calibration tolerances; and*
    b. *when the parameters of altitude and airspeed are provided by sensors that are dedicated to the FDR system, a recalibration shall be performed as recommended by the sensor manufacturer or at least every two years.*

The Accident aircraft's ZSCAR FDR was sent to Bureau d'Enquêtes et d'Analyses (BEA) in France for download under the supervision of a RSA investigator-in-charge (IIC) and the FDR analysis of the download are attached to this report as Appendix B and C.

1 - EQUIPEMENT EXAMINATION

This technical assistance from BEA has been required for the examination of FDR in the context of the safety investigation conducted by the AIID. The objective of the examination was the read out of FDR data.

Table: 12 FDR Data

Manufacturer	LORAL (L3COM)
Part number	S703-1000-00
Serial number	933

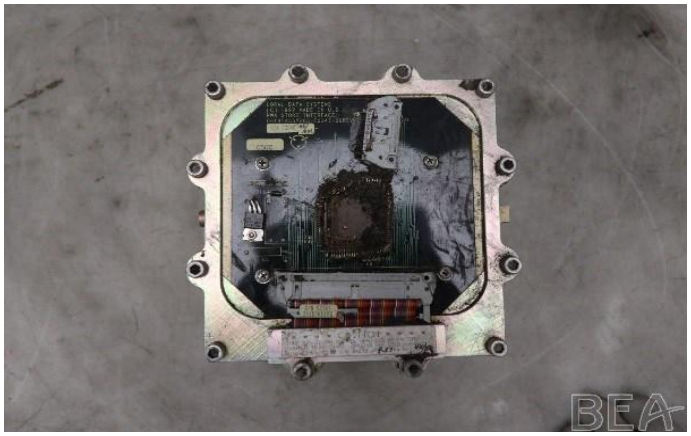


Figure 7: FDR F1000

Figure 8: ZS-CAR - Recorder opening & read-out - BEA - 3rd Feb 2020

The FDR was brought at the BEA on 3 February, 2020. The operations took place at BEA facilities in the recorder and avionics laboratories. The attendees' were French investigators and SA AIID's IIC.

2 - WORK PERFORMED

External visual Inspection

The FDR was visually examined. The chassis was missing, and only the FCSSU was brought to BEA. The PCB card was damaged and the FCSSU seemed compressed. The connector was dirty and the plastic package was broken.

Opening and Internal Visual Inspection

The FCSSU was opened. The main electronic board was extracted. It was in good condition. Inside the FCSSU, the electrical flat ribbon seemed in good condition. It was decided to perform a first electrical check with the connector of the event.

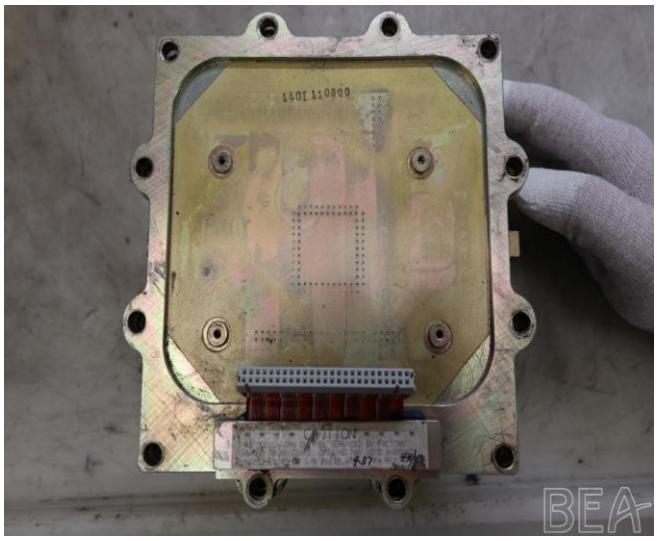


Figure 9: FCSSU Internal Check

Figure 10: Electrical Flat Ribbon

The download was performed using the manufacturer official software ROSE. It was successful and two files were generated:

- A .FDT file named ZS-CAR_raw_data.fdt of 8'193 kB. (Finger print SHA 256:

D68753F81B80720469B475072F4FE35D7F5B0656782A3BE4484E404CEB1F4209)
- A .pak file named ZS-CAR_raw_data.pak of 34'711 KB. (Finger print SHA 256:

6A15589076E98ADFF2179E18EB725FA3D64AAAC416A802D78B6D133ACD0DDE50)

The pak file was synchronized using the BEA dedicated software.

More than 360.000 seconds of synchronized data (around 100 hours of flight) were retrieved including the flight of the event.

The raw data were decoded using the 64 words per second standard data frame defined in the *ARINC 542A specification (64-Word frame)*.

3 - RESULTS

Recorded parameters

The following parameters were successfully decoded:

1. IAS pneumatic
2. Altitude pneumatic
3. Magnetic heading
4. Roll
5. Pitch
6. Vertical acceleration
7. Longitudinal acceleration

It was not possible to validate other mandatory parameters, because the aircraft was only triggered with the above parameters.

The required other mandatory parameters which were not recorded:

1. OAT (outside air temp)
2. Lateral acceleration
3. Engine thrust power
4. Pitch trim surface position
5. Warnings
6. Primary flight control surface and primary flight control pilot input
7. Marker beacon passage
8. Each navigation receiver frequency selection
9. Manual radio transmission key and CVR/ FDR synchronization reference

The operator was not in compliance with Part 135.05.10 read together with SA-CATS Part 135.05.10.

Generated files

One CSV file containing 7 decoded parameters was generated for the last two flights in cumulated time(TCC).
Two plots were also generated:

- One plot for the whole flight of the event (APPENDIX – Figure 15),
- One plot for the end of the flight of the event (APPENDIX – Figure 16).

Time used for both plots was shifted from 368.969 seconds in order to have a cumulated time since thepower-on of the recorder during the flight of the event: Event Flight Time (s).

Event Flight Time (s) = TCC (s) - 368.969 (s)

1.11.2 The aircraft was not fitted with a cockpit voice recorder (CVR) nor was it a requirement to haveone installed according to CAR 2011, Sub-Part 135.05.11, read together with SA-CATS 135.05.11.

ICAO Annex 6, Volume 1, Chapter 6, standard 6.3.2.1.4 requires:

All aircrafts of maximum certified take-off mass of over 5700kg for which the individual certificate ofairworthiness is first issued on or after 1 January 1987 shall be equipped with a CVR.

ICAO Annex 6, Volume 1, Chapter 6, Recommendation 6.3.2.1.5 states the following:

All turbine-engine aircrafts, for which the individual certificate of airworthiness was first issued before 1 January 1987, with a maximum certificated take-off mass of over 5,700 kg up to and including 27,000 kg that are of types of which the prototype was certificated by the appropriate national authority after 30 September 1969 should be equipped with a CVR.

1.12 WRECKAGE AND IMPACT INFORMATION

The accident aircraft approached the accident site from a southerly direction and impacted the ridge at an elevation of 2192ft AMSL. According to the wreckage debris, the impact corresponded with the aircraft being at a shallow angle on an upslope terrain. The area surrounding the wreckage consisted of rocks and grassland. The wreckage spread was distributed in a radius of 270m.

The height of the mountain where the aircraft impacted was at 2192ft AMSL at GPS co- ordinates 33°55'24" South, 22°06'30" East.

According to the available FDR graph plot, the aircraft impacted the terrain at an indicated airspeed of approximately 286 knots. Figure-11 indicates the position of all main components found at the accident site.

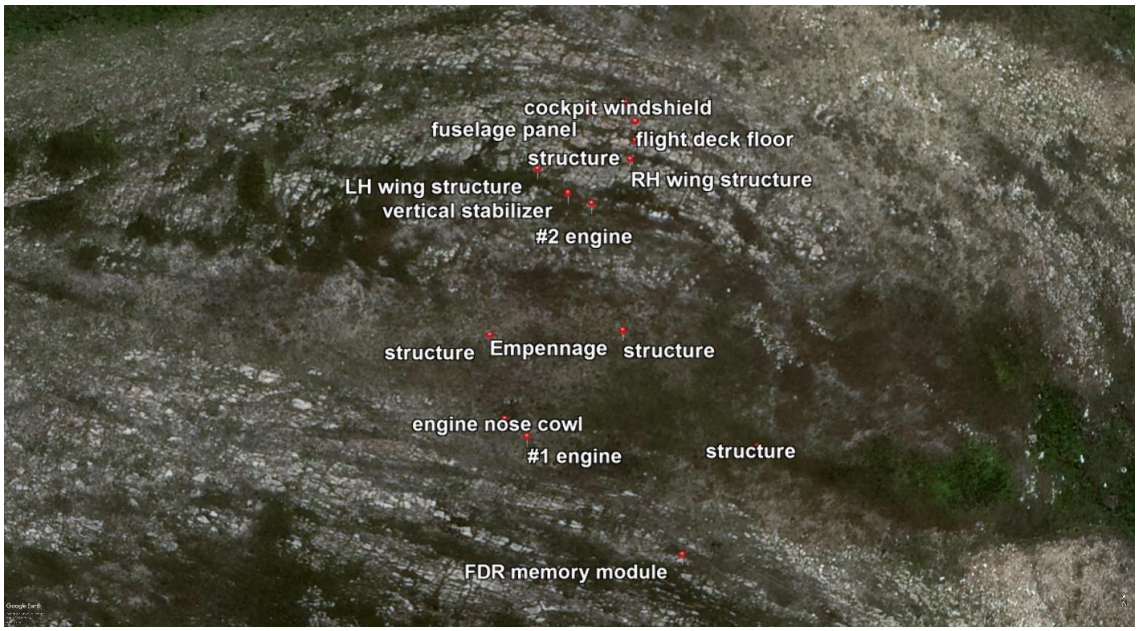


Figure 11: The Layout of the Main Aircraft Components Field. (Source: Google Earth)

The Investigators group, assessing the accident site divided the accident debris field into three zones. The first zone spans from the point of initial impact to 90m, the second zone from 90m to 180m, and the third zone from 180m to 270m.

Zone one (refer to Figure 12)

Debris in this zone consisted of empennage-related items such as the engine fire extinguisher bottles, the FDR and the high frequency (HF) receiver. The first portion of the rear cabin interior was found approximately 35m from the point of initial impact.

The upper left portion of this zone includes debris from engine No 1 nose cowl, shroud and piping.

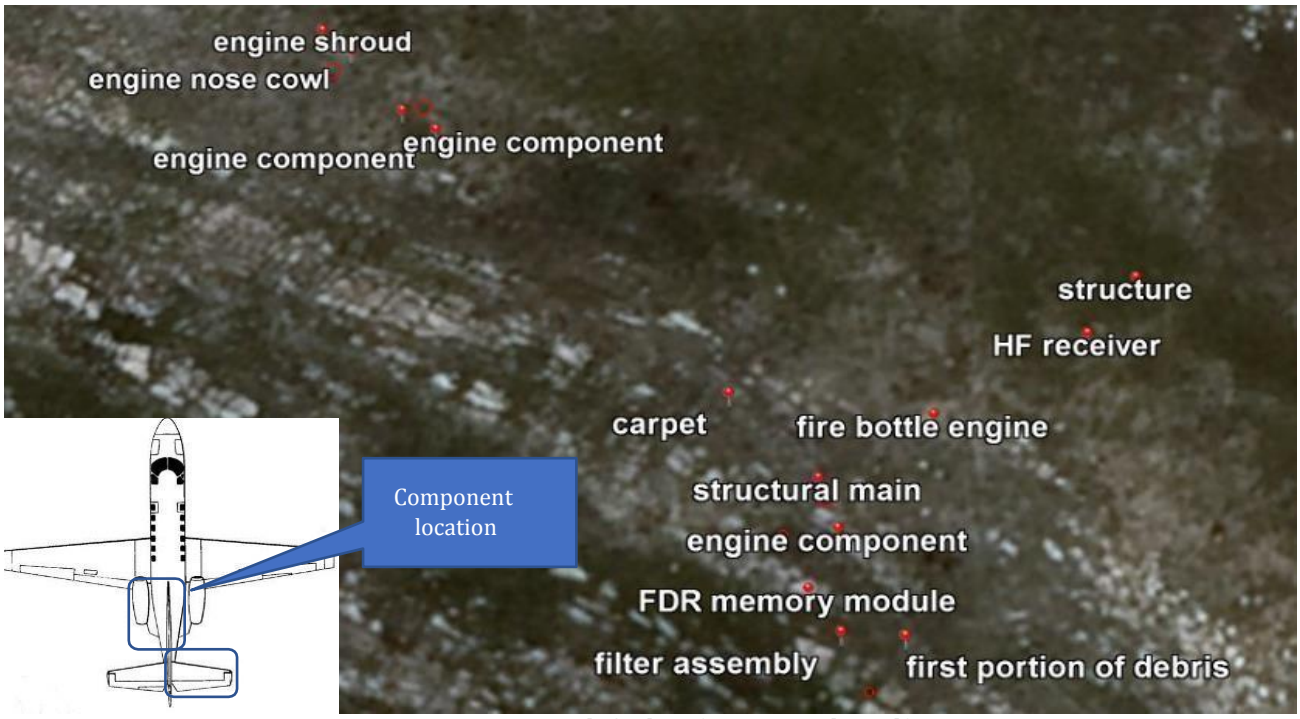


Figure 12: First Spread of Debris. (Source: Google Earth)

Zone two (refer to Figure 13)

This portion of the debris field formed the main area of debris spread and consisted largely of the fuselage and wing structure. Cabin items such as arm rests and carpets were also located in this area. The left wing remained largely intact and the right wing had severe damage and was highly fragmented. The left-hand elevator was destroyed, and the vertical stabilizer came to rest approximately 125m from the initial point of impact. This portion of debris experienced post-impact fire damage.

Zone three

Debris in this area comprised pieces of wing and fuselage which may have been distributed by impact forces.

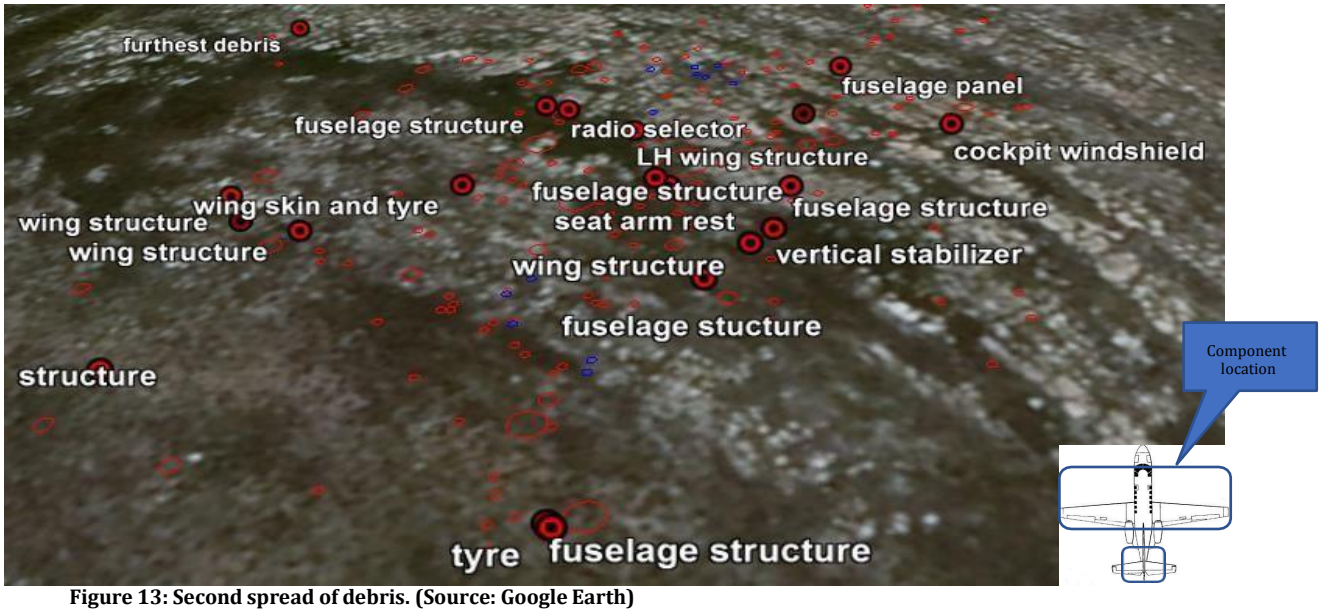


Figure 13: Second spread of debris. (Source: Google Earth)

1.13 MEDICAL AND PATHOLOGICAL INFORMATION

Autopsy and body examination data made available on DNA analysis of all recovered human remains allowed the identification of all persons who were on board and autopsy examination concluded that the human remains were infection free. All reports observed through clinical examinations the absence of burns, wounds and cyanosis. Some of them concluded that "the death is the consequence of a violent trauma, with projection of the passengers against a hard surface and ground impact of the aircraft resulting in severe vital lesion that led to immediate death. All passengers suffered even more severe physical consequences that did not allow any autopsy to be carried out. However DNA was extracted from recovered human remains of crew was identified. The medical forensic reports concluded that passengers died as a result of multiple fractures.

1.14 FIRE

The aircraft sustained a post-impact fire.

Figure 14: The Close-Up View of the Red Circled Area in Figure 14 below

Figure 15: The Red Circle Indicates the Fire Damage on the Surrounding Vegetation.

1.15 SURVIVAL ASPECTS

The accident was considered not survivable because of the damage caused by impact forces which destroyed the aircraft.

After the aircraft went off the radar, a DETRESFA was declared by ATC and the search and rescue commenced with emergency helicopter on standby. The aircraft was located approximately an hour after going off radar by the search and rescue helicopter. The emergency helicopter was

dispatched to the site and arrived approximately 10 minutes after the wreckage of the aircraft was located.

Due to inclement weather conditions at the time, the search and rescue was suspended until the next day.

1.16 TESTS AND RESEARCH

Phases of flight to FDR analysis

Phase one

00:20:15 - 00:21:00

- The aircraft pitch increased from +5 and decreased to +2 degrees.
- The aircraft altitude increased from 2900 ft to 3900 ft
- The aircraft airspeed increased from about 210 to 245kts.
- The aircraft magnetic heading was generally constant at 37.5 degrees until about00:20:45 when it increased to 67.5 degrees
- The aircraft roll was about zero degrees and began to increase to 35 degrees at00:20:45.

In the first phase of flight the aircraft pitch decreased from 5^0 degrees to two degrees with an increase of its speed to 245kts at the same time the altitude increased from 2900ft to 3900ft. In this phase the aircraft roll was about zero degree but immediately it began to deviate to 35^0degrees even if the aircraft magnetic heading was constant (37.5^0) at about 00:20:45 it changed to nearly double of the first heading which is plotted on the graph.

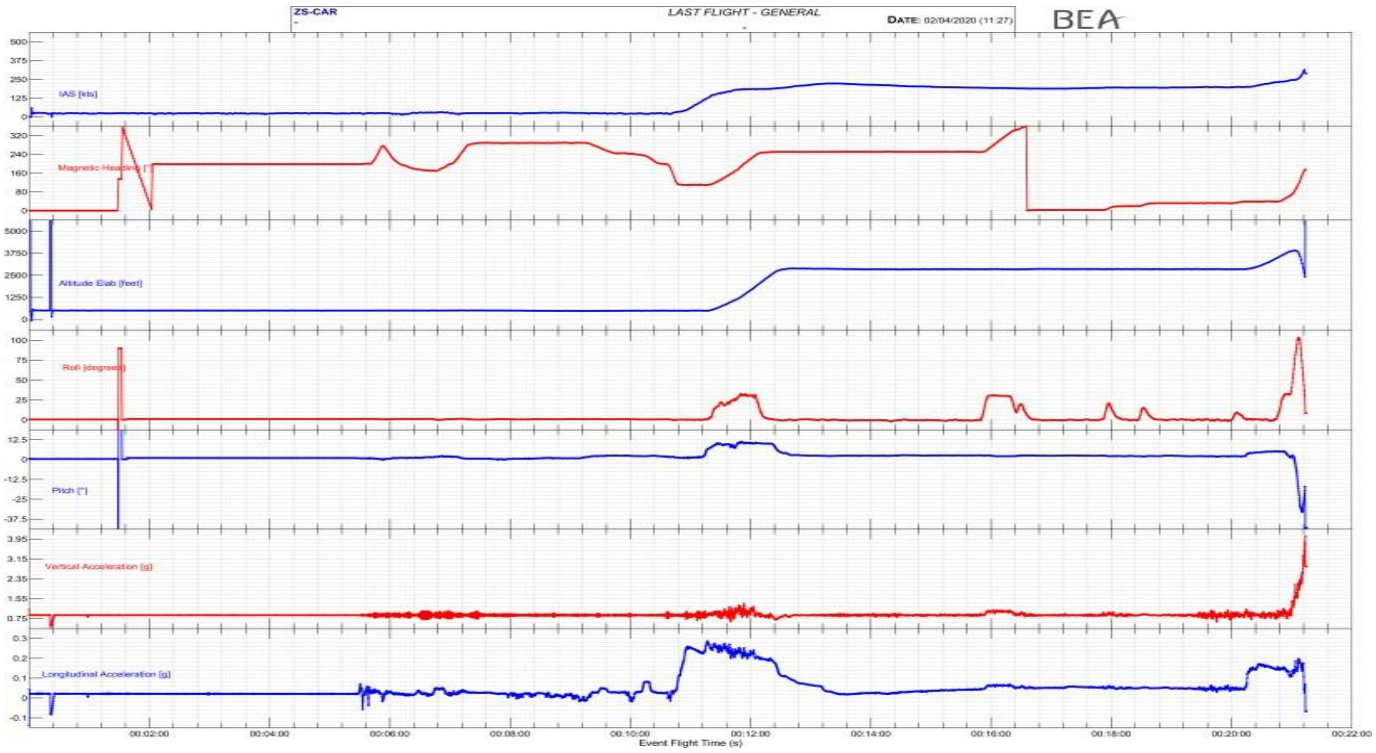


Figure 16: General View of the FDR Analysis

Phase two:

00:21:00 - 00:21:10

- The aircraft pitch decreased from about +2 to -10 degrees from 00:21:02 to 00:21:05and over the next 5s decreased to -32.5 degrees.
- The aircraft altitude decreased from 3900 to 3200 ft between 00:21:00 - 00:21:05 andthe next 5s decreased to 2800 ft.
- The aircraft airspeed increased from 245 to 275kts.
- The aircraft magnetic heading increased from 67.5 to 150 degrees.
- The aircraft roll increased from about 35 to 105 degrees during the period of 0:21:00 -00:21:07 and then over the next 3s decreased to 75 degrees.

In the second phase of flight the aircraft was flying with nose down to -32.5 degrees decreasing its altitude to 3200ft and 2800ft. The aircraft heading changed to 150degrees and its roll to 105 degrees which was overbanked and immediately changed to 75^0; which can't be determined why the roll of the aircraft suddenly changed from 35 to 105 degrees and then to 75^0.

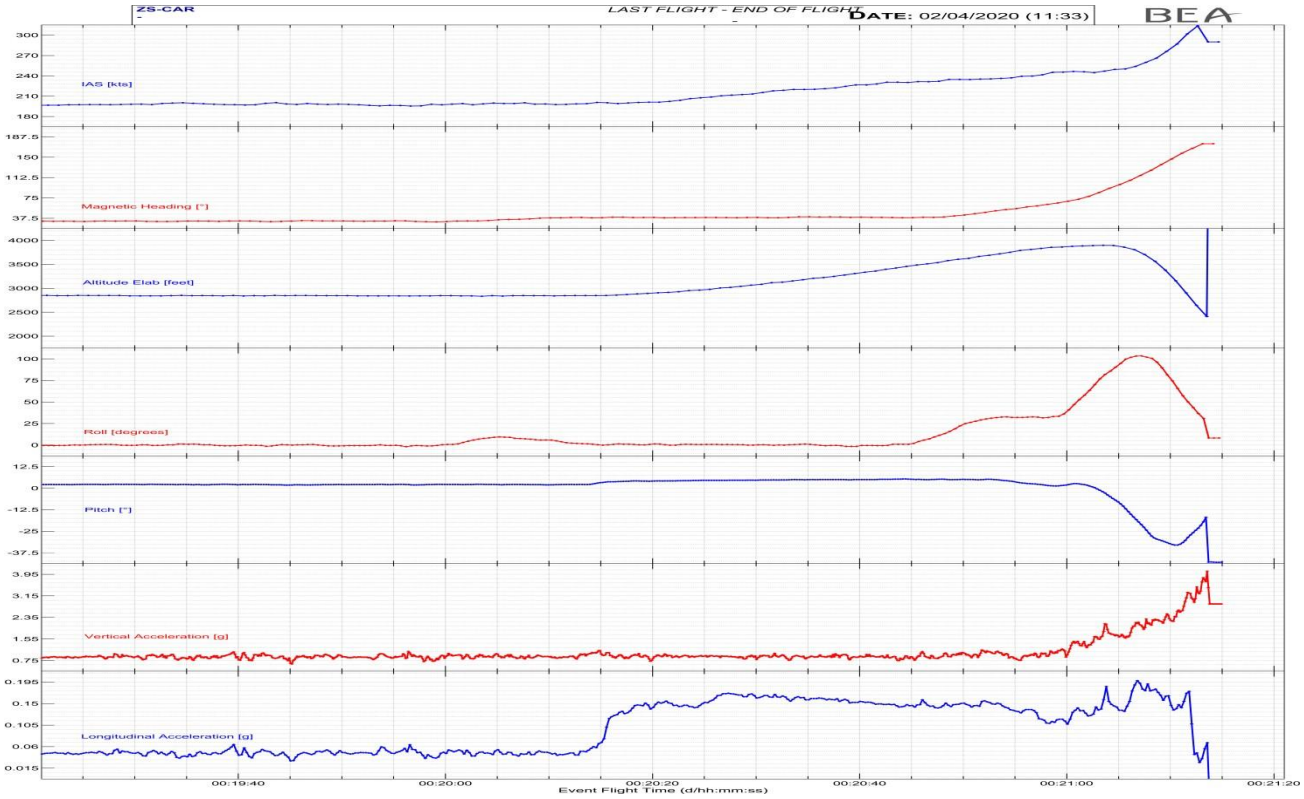


Figure 17: Last Event Flight

Phase three:

00:21:10 - 00:21:13

- The aircraft pitch increased from -32.5 to -17.5 degrees.
- The aircraft altitude decreased from 3200 to 2400 ft.
- The aircraft airspeed increased from 275 to 310kts during the period of 00:21:10 to 00:21:12 and one second later the airspeed was 290kts.
- The aircraft magnetic heading increased from 150 to 177 degrees.
- The aircraft roll decreased from 75 to 10 degrees.

In the third phase of flight the aircraft with nose down moment (-17.5^0), altitude, speed and roll decreased as it is indicated on the graph. The altitude of the aircraft was at a lower level when it was compared with the surroundings.

1.17 ORGANIZATIONAL AND MANAGEMENT INFORMATION

1.17.1 The South African Civil Aviation Authority

The South African Civil Aviation Authority (CAA) is a stand-alone government agency responsible for the promotion, regulation and enforcement of civil aviation safety and security regulations in South Africa.

The SACAA areas of responsibility include administrative reporting of the AIID to the Director of Civil Aviation, carried out on behalf of the Department of Transport: calibrate radio navigational aids usedby aircraft to ensure accuracy and reliability and others.

The Ministerial Order was signed on 26 May 2016 by the Minister of Transport regarding the separation of duties of the Accident and Incident Investigations Division (AIID) from the SACAA.

The contents of the Ministerial Order connotes that the staff complement of the AIID will report through the Executive Manager: AIID to a nominated official in DoT on a functional basis. However, AIIDwill continue to be part of the SACAA administratively.

1.17.2 Flight Inspection Unit

The flight inspection unit (FIU) of the South African Civil Aviation Authority (SACAA) is the provider of flight inspection (flight calibration) services in South Africa as designated by the department of Transport. The FIU inspection services were conducted based on the following approvals:

- Air Service Licenses (International and Domestic);
- Air Operating Certificate (Part 135 Operations);
- Part171approval—electronic service organization (ESO)(Communication, Navigation and Surveillance)

PART 171 REQUIREMENTS–AERONAUTICAL TELECOMMUNICATION SERVICE PROVIDERS(ELECTRONIC SERVICES ORGANIZATIONS)

Flight inspection services require approval in terms of Part 171of the civil Aviation Regulations, 2011. The fundamental requirements are the following:

- Application for Approval or amendment made to DCA (171.02.6)
- Meet requirements for Approval (171.01.2)
- Be subjected to part 171 Safety inspections and audits (171.01.5)
- Approved manual of procedure (171.02.1)
- Quality assurance system (171.02.2)
- Approval of facilities, personnel and equipment (171.02.3-5)

The provisions of CAR Part 171(Electronic Service Organization) require a prospective service provider for flight calibration services to seek and obtain the necessary approval from the SACAA. It is an essential requirement for a service provider to possess CAR Part 171 Electronic Service Organization(ESO) approval with Type F certificate.

According to the evidence records presented, it is evident that the FIU Part 171 ESO approval had expired in 01 April, 2019, and that they were only reissued the approval on 5 November 2019.The FIU continued to provide electronic services (calibration of navigational aid) between April 2019 and 4 November 2019 without an approval, and this was in contravention of CAR Part 171.01.2 (1) which states:

171.01.2 *(1) No person or organization shall install, maintain, repair, modify or calibrate—*

(a) equipment for the use of aeronautical telecommunication services used for air traffic services; or

(b) equipment for the use of aeronautical radio-navigation services, used for air navigation, except, under the authority of, and in accordance with the provisions of, an electronic services organization approval with the appropriate rating issued under this part and in accordance with the requirements prescribed in Document SA-CATS 171.

Further evidence records show that the FIU approval issued on 5 November 2019 with an expiry date of October 2020 was irregular. The operator (FIU) was issued Part 171 approval as ESO; however based on the evidence records, FIU did not meet the minimum requirements of CAR Part 171.02.4 (1)
(a) which states:

The applicant shall engage, employ or contract—

(a) a senior person identified as the accountable manager and ***compliance officer*** *of the organization concerned, to whom contractual authority has been granted to ensure that all activities undertaken by the organization are carried out in accordance with the applicable requirements prescribed in this subpart, and who shall in addition be vested with the following powers and duties in respect of the compliance with such requirements—*

The FIU did not engage, employ or contract compliance officer and that was in contravention of CAR Part 171.01.2(1) (a).

At the time of the accident, based on the evidence records obtained from Air Service Licensing Council, the Director of Civil Aviation Authority was also holding the position of Accountable Manager and CEO of Flight Inspection Unit (FIU).

1.17.3 FIU Training Instructions

The FIU Operation Manual has been prepared in four parts in accordance with the South African Civil Aviation Regulation, 2011 and complied with all applicable and duly promulgated with SACAA

Regulations, and terms and conditions of the FIU Operation Certificate.

In accordance with CATS 135-04.2 the OM is structured as:

a) Part 1-General
b) Part 2-Aeroplane Operating Matters
c) Part 3- Route and Aerodrome Instructions
d) Part 4-Training

Part -4 comprises all training instructions for personnel required for a safe operation. Some of the trainings specified under Part-4 are:
1.3 FIU provides ground and flight training to the pilot prior to conducting a calibration flightsequentially-:

i) flight training on any differences in the use of any equipment installed in FIU aircraft that was notinstalled in the aircraft on which the initial training took place, such as navigational aids, auto flight system, flight director/FMS, ACA, TAWS, weather radar, etc, in theaircraft or approved flight simulation training device (FSTD): and

ii) Sufficient flight training in the aircraft or an approved full flight simulator (FFS) of the type tobe flown to ensure the pilot becomes proficient in the use of FIU SOP's

a) 1.4.5 Recurrent technical Training

Technical Proficiency checks will be carried out on each aircraft type flown by pilots at intervalsof not more than 6 months .These refresher will be followed by a technical examination on the type.

b) 1.5.1 Six Monthly operating proficiency Checks (All SA-CARS 135.03.7)

FIU shall ensure that, in the case of the operator proficiency check: (FIU operation Manual part 41.5.1)

1. Each flight deck crew member undergoes such checks to demonstrate his or her competence in carrying out normal, abnormal and emergency procedures every 6 months; and
2. Such check is conducted without external visual reference when the flight deck crew member will required operating under IFR.
3. Upon successful completion of the operator proficiency check referred to in 1.1 above, FIU shall issue a certificate of competency to the flight deck crew member concerned, which certificate shall be valid for a period of six calendar months calculated from the last day of the calendar month in which such certificate is issued.
4. FIU shall ensure that, in the case of an operational check, each flight deck crew member

undergoes the operational check on the aircraft to demonstrate his or her competence in carrying out normal operations specified in this operations manual.

5. Upon successful completion of the operational check referred to in 4 above, FIU shall issue a certificate of competency to the flight deck crew member concerned, which certificate shall be valid for a period of 6 calendar months calculated from the last day of the calendar month in which such certificate is issued.
6. The operator shall ensure that, in the case of emergency and safety equipment training and checking, each flight deck crew member undergoes training and checking on the location and useof all emergency and safety equipment carried.
7. Upon successful completion of the emergency and safety equipment check referred to in 6 above, FIU shall issue a certificate of competency to the flight deck crew member concerned, which certificate shall be valid for a period of 6 calendar months calculated from the last day of the calendar month in which such certificate is issued.
8. A PIC designated by FIU in the case of line checks; and

Each flight deck crew member undergoes operator proficiency checks every six calendar months as part of a normal flight deck crew complement.

SACAR Part 135: Air Transport Operation Sub section 3
Training and pilot Proficiency or Competency check validity periods 135.03.6(3)
Except as provided in technical standard 135.03.6 of Document SA-CATS 135, the following checkingvalidity periods shall apply.

(a) For flight crew members----

Except as provided in subparagraph (ii), a PPC or competency check is valid to the first day of theseventh month following the month the PPC or competency check took place.

According to operation manual part 4, 1.3 b the FIU provides flight training to the pilot prior to conducting a calibration flight

i. Flight training in any differences that may exist between FIU model of aircraft and that on which the initial training took place, including, at least, systems, engine,/ airframe, performance and operating differences;

ii. flight training in the use of any equipment installed in FIU aircraft that was not installed in the aircraft on which the initial training took place, such as navigational aids, auto flight system flight director / FMS, ACAS, TAWS, weather radar, etc in the aircraft or an approved flight simulation training device (FSTD) and,

iii. sufficient flight training in the aircraft or an approved full flight simulator (FFS) of the type to be flown to ensure the pilot becomes proficient in the use of FIU SOPs;

1.2.2 Crew Resource Management training /CRM/

Crew Resource management training will be provided to flight crew members together with initial training recurrent crew resource management training will be conducted within every 12 months. FIU shall ensure a flight crew member has received crew resource management training including human factors, risk analysis and error and threat management training. upon initial appointments to FIU unless such person has, within the preceding 12 months, received CRM training from another approved training organization. In such cases, FIU shall provide the flight crew member with training in those elements of CRM that are company – specific; and

a) on recurrent basis every 12 months thereafter.

Each flight deck crew member undergoes recurrent training and checking and that all such training and checking is relevant to the type or variant of aircraft on which the flight deck crew member is licensed to operate.

1.17.4 Unusual Attitudes and Recoveries

An unusual attitude is an aircraft attitude not normally required for instrument flight. Unusual attitudes may result from a number of conditions, such as turbulence, disorientation, instrument failure, confusion, preoccupation with flight deck duties, carelessness in cross-checking, errors in instrument interpretation, or lack of proficiency in aircraft control. Since unusual attitudes are not intentional maneuvers during instrument flight, except in training, they are often unexpected, and the reaction of an inexperienced or inadequately trained pilot to an unexpected abnormal flight attitude is usually instinctive rather than intelligent and deliberate. This individual reacts with abrupt muscular effort, which is purposeless and even hazardous in turbulent conditions, at excessive speeds, or at low altitudes. However, with practice, the techniques for rapid and safe recovery from unusual attitudes canbe mastered.

When an unusual attitude is noted during the cross-check, the immediate problem is not how the aircraft got there, but what it is doing and how to get it back to straight-and-level flight as quickly as possible in believing the instruments.

Unusual Attitude Recovery is practiced by simulator during instrument recurrence once a year minimum.

1.17.5 Recognizing Unusual Attitude

As a general rule, any time an instrument rate of movement or indication other than those associated with the basic instrument flight maneuvers is noted, assume an unusual attitude and increase the speed of cross-check to confirm the attitude, instrument error, or instrument malfunction. When an unusual attitude is noted during the cross-check, the immediate problem is not how the aircraft got there, but what it is doing and how to get it back to straight-and-level flight as quickly as possible.

In order to provide Flight Safety customers with flight simulator exercises, useful in some circumstances, Flight Safety has included flight simulator training events in this training program addressing "unusual Attitudes" which can be conducted within the defined envelope of flight simulator operation. When a manufacturer provides predictable data from the aircraft and that data is programmed into the flight simulator, Flight Safety will train to the manufacturer's recommended procedure for recognition, and recovery from unusual attitudes.

Excursion outside of this defined envelope cannot be considered as representing the behavior of the actual aircraft. Demonstrations of maneuvers outside of the defined flight simulator operating envelope may be conducted at the direction of the center Manager with the caution that such demonstrations represent our best opinion of aircraft behavior, but cannot be considered accurate.

Figure 18: Unusual attitude—nose-low (Source: Sky brary Aviation safety)

1.17.6 Recovery from Unusual Attitudes

In moderate unusual attitudes, the pilot can normally reorient by establishing a level flight indication on the attitude indicator. However, the pilot should not depend on this instrument if the attitude indicator is the spill able type, because it's upset limits may have been exceeded or it may have become inoperative due to mechanical malfunction. If it is the non spill able-type instrument and is operating properly, errors up to 5 degrees of pitch-and-bank may result and its indications are very difficult to interpret in extreme attitudes. As soon as the unusual attitude is detected, the recommended recovery procedures stated in the POH/AFM should be initiated. If there are no recommended procedures stated in the POH/AFM, the recovery should be initiated by reference to the ASI, altimeter, VSI, and turn coordinator.

Unusual Attitude Recovery Procedures:

- Reduce power as necessary to prevent excessive airspeed and loss of altitude.
- Level the wings by applying coordinated aileron and rudder pressure.
- Raise the nose to level flight attitude by smoothly applying back elevator pressure.
- Return to the original altitude and heading.

1.17.7 Flight Profile for RWY 11 at FAGG

The flight was conducted in accordance with the provisions of Part 135 of the CAR 2011 as amended. The operator (FIU) had been issued with an air operating certificate (AOC) number: CAA/N942D by the Regulator (SACAA) on 26 April 2019 with an expiry date of 30 April 2020.
At the time of the accident, the aircraft was calibrating the ILS system for RWY 11 at FAGG. According to the FIU operations manual,

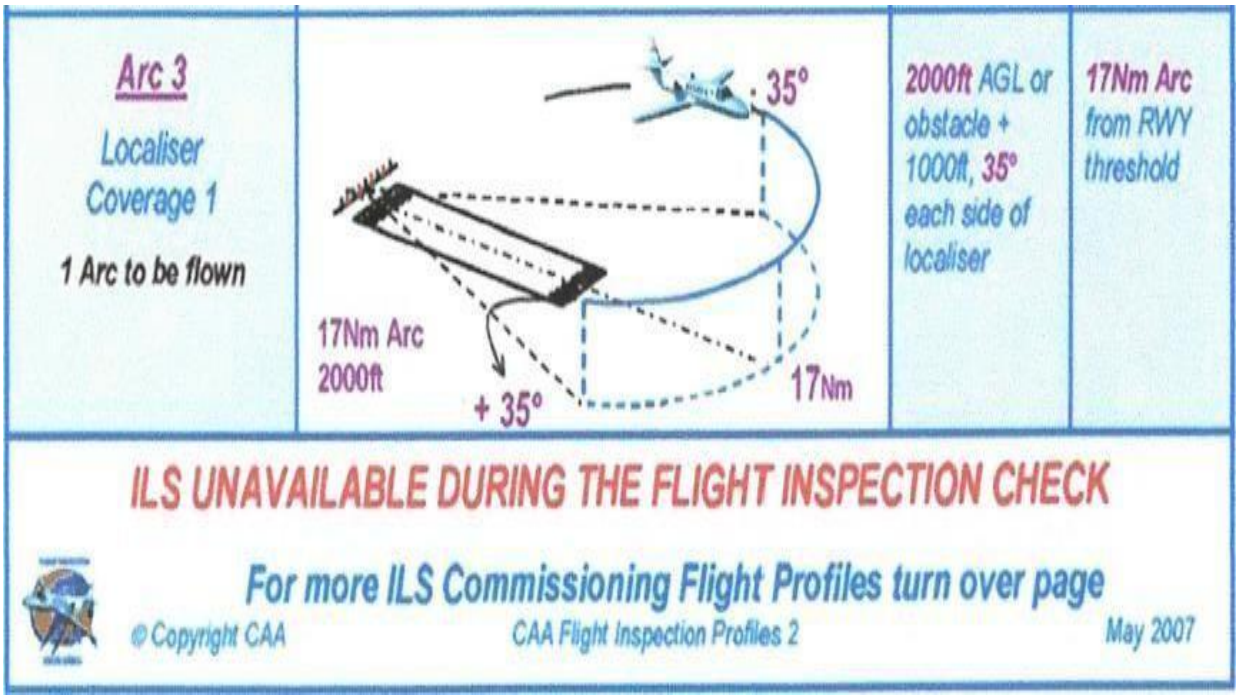


Figure19: The ILS procedure. (Source: FIU Operations Manual)

process requires the aircraft to fly 35° on either side of the runway centre line while maintaining a 17NM DME arc. The height for the operation is 2000ft AGL or obstacle plus 1000ft. Refer to Figure 17.The AMO that carried out the last maintenance inspection on this aircraft prior to the accident flight had been issued with an AMO approval certificate on 31 October 2019 with an expiry date of 31 October 2020.

1.18 ADDITIONAL INFORMATION

Reported Incidents (ZSCAR) In the Past 12 Months Prior to the Accident

On 2 March 2019, engine No1 did not respond to throttle movement due to a damaged cable. The operator, through the AMO, replaced the damaged cable on engine No 1.

On 7 November 2019, the aircraft was on approach for Wonder Boom Aerodrome (FAWB) when the flying crew experienced an oil smell and smoke in the cockpit; the AMO carried out maintenance to rectify the defect and, following the maintenance, the aircraft was released to service.

On 8 November 2019 during the take-off roll, the crew experienced smoke in the cockpit. The crew decided to abort take-off, and the aircraft was taxied back to the hanger before the engines were shut down. The AMO further investigated the incident and found out that there was a seal leaking in the engine and that resulted in the AMO replacing the defective engine.

1.19 USEFUL OR EFFECTIVE INVESTIGATION TECHNIQUES

The South African AIID made an operational agreement with the Ethiopia AAIB delegating the fatal accident investigation of Cessna S550, ZS- CAR. As per Annex 13 to the Chicago Convention article 5.1, which States: The State of occurrence shall institute an investigation into the circumstances of the accident and be responsible for the conduct of the investigation, but it may delegate the whole or any part of the conducting of such investigation to another state or a regional accident and incident investigation organization (RAIO) by mutual arrangement and consent. As per the convention the Ethiopian AAIB agreed and signed MOU for the mentioned fatal accident to investigate and provide the full report to the South African AIID (ICAO Annex 13, Chapter 5, and Article 5.1).

2. ANALYSIS

In accordance with Annex-13, the AAIB Rules and Standards and the South African AIID Regulation the investigation committee assessed all the required data, the relevant records of FDR, ATS communication, including crew training and proficiency and other information's collected and analyses done accordingly.

The analysis will also discuss the additional safety issues that were identified prior to the accident flight, such as basic Aircraft design, Aircraft certification, and organizational issues.

2.1. Flying Crew

The ZS-CAR flying crew was issued pilot license by the SACAA to fly the mentioned aircraft. The Pilot-in- command Pilot Proficiency Check found current and expires on May 07, 2020. The PIC had been issued with a class 1 aviation medical certificate on 23 October 2019 with an expiry date 31 October 2020. PIC had completed approximately 20 hours of flight calibration of navigational AIDs at FAGG

signifying that the PIC was not new for the mentioned aerodrome. Pilot in command of ZSCAR was the chief pilot andat the same time he was an operation officer in the SACAA.

> CAR Part **135.03.5** *(1) No air service operator may assign nor may a PIC or second-in-command, if applicable, accept an assignment to operate an airplane under this part unless he or she has completed thecheck requirements specified in Document SA-CATS 135.*
>
> The SACAA FIU (Operator) contravened CAR Part 135.03.5 - the pilot in command was assigned to fly the accident airplane.

The FO had been issued with a class 1 aviation medical certificate on 26 September 2019, expiring on 31 July 2020. The PIC and FO had completed approximately 20 hours and two hours of flight calibrationof navigational AIDs at FAGG respectively. As a crew pairing, the PIC and FO had completed approximately 200 hours of flight calibration of navigational AIDs including 58 VOR and 50 ILS calibrations.

As it was indicated from their records both of them have valid licenses and qualifications. Crew total Flying time and performance for performing VOR and ILS calibration was sufficient to maintain the aircraft.

The operation manual of FIU has been prepared in accordance with the South African Civil Aviation regulation, 2011 and complies with all applicable and duly promulgated South African Civil Aviation regulations and terms and condition of the FIU operating certificate.

According to SACAA operation manual part four section1.5.1 of the operation manual (six monthly) operator proficiency checks with the SA –CARS 135.03.7 each flight deck crew member undergoes such checks to demonstrate his or competence in carrying out normal abnormal and emergency procedures every six months and such check is conducted without external visual reference when the flight deck crew number will require operating under IFR. Upon successful completion of the operator proficiency check, the FIU shall issue a certificate of competency to the flight deck crew members concerned, which certificate shall be valid for a period of six calendar months calculated from last day of the calendar month in which such certificate is issued.

The PIC was the chief pilot and additionally he was manager operation of FIU under the SACAA. The PICproficiency check expires on May 7, 2020 in accordance with the SA –CARS 135.03.7. The Simulator six months Proficiency Check of unusual attitude recovery was not found and indicated in PIC grade slip. This indicated that lack of supervision of the operator based on C of A not valid. This indicated lack of supervision of the operator based on C of A not valid.

2.2 The Accident Flight history

The crew departed for Port Elizabeth Aerodrome (FAPE) on a positioning flight to George Aerodrome (FAGG). The flying crew requested to carry out a calibration flight for the very high frequency Omni Directional range (VOR) beacon at FAGG and this was confirmed and accepted by the ATC. At its arrival

to FAAG the weather was inconvenient to perform VOR. According to the SAWS report "Significant clouds below 1,500ft was above ground level (AGL). There was no indication of drastic wind direction or speed changes, and no low level turbulence was forecasted or observed in the area. As it was confirmed from the Webcam Mountain tops were obscured with clouds. Therefore, due to weather conditions the first intention of calibration of flight for VOR was changed to ILS calibration. The decisions were also changed to land at FAGG for refueling and wait until it gets clear for commencing ILS calibration.

The FO of ZSCAR acknowledged to perform ILS calibration at 3000ft RWY11QNH 1018, intercept radial 250 and fly in 17 DME clockwise arc from radial 250 to 330 at 3000ft climbing to 4000ft position, but instead of holding at 3000ft it reached to 3900ft for climbing 4000ft. The Radar data showed that immediately after airborne (08:42Z) crew made a right turn to intercept radial 250° using the George VOR (GRV VOR). Once the aircraft reached 17NM on the DME from the GRV VOR (DME was co-located with the VOR), it commenced with a right-hand turn to intercept radial 330° while maintaining 17NM DME arc.

At 08:44:25 APP controller (composite) briefed the TWR controller on ZSCAR's intentions for the rest ofthe calibrations for RWY 11. At 08:44:48 ZSRx1 called APP to advise that he is airborne and routing west bound to clear CTR. At 08:46:10 the ATC gave advice that ZSCAR is outside the TMA, broadcast 124.2 for traffic below the TMA. Lately the radar was showing that the aircraft was climbing and starting right turn to level off at 4000ft, almost after 50s a rapid descent occurred, and the aircraft lost 1500ft in approximately 9 seconds; three seconds prior to impact, the aircraft nose was pitched up before impacting the terrain at 2192ft.While it started disappearing from the radar crew did not call and request advice from APP or TWR and even did not declare the situation they are in, totally disappeared from radar before calling "MAY DAY" "MAY DAY". The crew took off and turned to the rightmaintaining 17 NM, while flying 17NM DME arc crew might have been entered in the cloud and came into unusual attitude. The crew lost control of the airplane, which was not possible to establish the reason for the loss of control due to mandatory parameters not recorded on the FDR.

2.3 FDR Data Analysis

The FDR data was not triggered with 9 mandatory parameters; therefore it was not possible to validate other mandatory required parameters because the aircraft was only triggered with thelimited parameters and that brought limitations to the investigation.

The required mandatory parameters which were not recorded are as follows:

1. OAT (Outside Air Temp)
2. Lateral acceleration
3. Engine thrust power
4. Pitch trim surface position
5. Warnings

6. Primary flight control surface and primary flight control pilot input
7. Marker beacon passage
8. Each navigation receiver frequency selection
9. Manual radio transmission key and CVR/ FDR synchronization reference

The operator (FIU) was not in compliance with Part 135.05.10 read together with SA-CATS Part 135.05.10.

Keeping the 17 NM arc the aircraft turned to the right to a heading of 67.5^0; at this point the aircraft's roll was zero degrees, but all of a sudden it began to increase to 35^0 degrees and the aircraft pitch decreased from 2 degrees to -10 degrees and then within 5 sec decreased to -32.5 degrees. The aircraft descended to 2800ft within 5 sec and the airspeed increased from 245kts to 275kts. The magnetic heading changed from 67.5 to 150 degrees. This happened due to an increase of bank from 35 degrees to 105 degrees. The situation was a characteristic of an unusual attitude to an aircraft flying. Recognizing this attitude of the aircraft the roll decreased to 75 degrees with an increase of pitch from -32.5 to -17.5 degrees and at this moment there was 310knt, later on decreased to 290knt. Since the aircraft magnetic heading continued increasing to the right from 150 to 177 degrees, the aircraft roll decreased from 75 to 10 degrees, while the pitch was at -17.5 degrees on a nose low attitude put the aircraft at an altitude of 2400ft indicating that the aircraft was in a moderate dive and low altitude. The applied back pressure could not save it from impacting the ground at a height of 2192ft.

SAWS report about the weather was significant clouds below 1500ft above ground level (AGL) were present at the time of the accident as observed in the METARs and Mountain tops were obscured, but there was no indication of drastic wind direction or speed changes as seen on the report graph.

2.4 The Accident Aircraft Cessna S550

The accident aircraft was a Cessna S550 which was manufactured in 1986; it was fitted with two Pratt and Whitney Canada JT15D-4B turbo fan engines. The aircraft was used by the FIU of South Africa civil aviation to calibrate navigational and approach facilities and fitted with additional equipment (CARNAC-30) in the passenger compartment to allow the inspector on-board to carry out the calibration function.

The aircraft was issued the initial Certificate of Airworthiness on 26 October 1986; the last Certificate ofAirworthiness was reissued on 29 October 2019 with an expiry date of 30 October 2020. Due to non-compliance with Civil Aviation Regulations Part 43 requirements, the aircraft Certificate of Airworthiness was rendered invalid at the time of the accident in accordance with the following:

CAR Part 21.08.12 *(1) A certificate of airworthiness shall, subject to sub-regulation (2), be valid for a period of 12 months or until it is surrendered by the holder thereof, or is suspended by an authorised officer, inspector or authorized person, or cancelled by the Director.*

(2) Notwithstanding the provisions of sub-regulation (1), a certificate of airworthiness shall be rendered invalid if—

(a) the aircraft is removed from a South African aircraft register

(b) the aircraft is not maintained in accordance with the regulations prescribed in Part 43;

The ZS-CAR was not maintained in accordance with regulation Part 43.02.8 whereby the FDR annual inspection was not conducted. Therefore, at the time of the accident, the Certificate of Airworthiness was rendered invalid.

On 30 March 1988 at 351.20 hours, the aircraft was repaired following an incident which resulted in both wings being wrinkled forward of the main spar and stab wing; on 20 October 1993.
At 1284.45hours, the aircraft was damaged by a hail storm whilst on approach for the then Jan Smuts Airport, now O.R. Tambo International Airport.

Records of the airframe logbook further indicated that on 13 May 2011 at 7032.6 hours, the left engine with serial number 102187 was removed for overhaul and replaced with an overhauled engine with serial number 102175, which was originally fitted on the right hand side of the aircraft. Following the overhaul of the left engine with serial number 102187, the engine was fitted on the right-hand side of the aircraft on 15 September 2011 with a total time of 7032.6hrs. The aircraft had passed 34 years since theSACAA owned it. From its manufactured date the aircraft flew less hours when it is compared with its ground time. When it was calculated after the last incident, the aircraft was on the ground for three months.

On 15 January 2020, at 10090airframe hours the number one engine (left engine) with serial number PCE:70925 was replaced after 8 months in service at 8265.9hrs due to an oil leak resulting on an oil smell and smoke in the cockpit. The engine had accumulated a further 176.5 hours since the last overhaul.

2.5 Navigation AID

The accident aircraft was equipped with a Terrain Avoidance Warning System (TAWS) which provides warning to the flying crew when coming close to terrain. However, Due to Civil Aviation Regulations Part 135.05.11 not requiring the installation of a CVR to this type of accident aircraft, the investigation team was unable to determine and no evidence found if TAWS was operational at the time of the accident. The warning is one of the mandatory parameters required on the FDR and the aircraft was nottriggered to record such warnings.
The ARTEX C406-2 HM is an emergency locator transmitter (ELT) it transmits on all 3 emergency frequencies (121.5/243.0 and 406 MHz). The ELT automatically activates during a crash and transmits the standard swept tone on 121.5 and 243.0 MHz it also transmits a 406 MHz encoded digital message to the COSPAS/SARSAT satellite system, which allows first responders to quickly and accurately identify not only where you are, but who you are as well.

The aircraft was fixed with an Emergency Locator Transmitter (ELT) with the description ARTEX ELT

C406-2 with part number 453-5000 and serial number 170-07269. The ELT did not transmit a signal following the accident, and it was not found at the accident site. According to data gathered the ELT waslast bench-checked on 28 May 2019 and its battery changed on 2 October, 2019.

The ELT was unable to transmit accident signal this might be damaged or the antenna dismantled from the unit, the ELT may not be selected for its activation or its installation was incorrect.

The aircraft was equipped with standard communication equipment as per the equipment list approved bythe Regulator and there were no recorded defects prior to the accident. Earlier or after disappearing from Radar no emergency calls were made to the FAGG ATC.

3. CONCLUSIONS

3.1 Findings

Findings are statements of all significant conditions, events or circumstances in the accident sequence; but they are not always causal, or indicate deficiencies. Some findings point out the conditions that pre-existed the accident sequence, but they are usually essential to the understanding of the occurrence, usually in chronological order (ICAO Doc 9756 Part IV paragraph 3.1).
Based on the available evidence, the following findings were made with respect to this accident. These shall not be read as apportioning blame or liability to any particular organization or individual.

FINDINGS

1. The PIC had been initially issued with an Airline Transport Pilot License (ATPL) on 20 December 2011. His last skills test was carried out on 24 January 2019 and his license was issued on the same day with an expiry date of 29 February 2020. He was also issued with a class 1 aviation medical certificate on 23 October 2019 with an expiry date of 31 October 2020;

2. The FO had been initially issued with a Commercial Pilot License (CPL) on 16 May 2014. Her last skills test was carried out on 15 March 2019 and her license was issued on the same day with an expiry date of 31 March 2020. She was in possession of a class 1 aviation medical certificate issued on 26 September 2019 with an expiry date of 31 July 2020;

3. The air traffic controller (ATC) had been initially issued with an Aerodrome Control Air Traffic Services license on 28 February 2003. His last skills test was carried out on 14 August 2019 and his license was issued on the same day with an expiry date of 13 June 2020;

4. The ATC was issued with a class 3 aviation medical certificate on 19 February 2018 with an expiry date of 28 February 2020 and was issued with level 6 language proficiency certificates on 28 March 2007;

5. The aerodrome controller conducted last proficiency check on her aerodrome control license for FAGG and FAOR on 14 August 2019 and 8 July 2019, respectively;

6. The aerodrome approach controller had been initially issued with an Aerodrome Control Air Traffic Services license on 24 August 2007. His last skills test was carried out on 5 December 2019 and his license was issued on the same day with an expiry date of 4 December 2020;

7. The aerodrome approach controller was issued with a class 3 aviation medical certificate on 12

March 2019 with an expiry date of 31 March 2023. The aerodrome approach controller was issued with a level 6 language proficiency certificate on 20 August 2007. The Aerodrome Approach controller also did proficiency on approach control surveillance for FAGG on 26 April 2019 and had an expiry date of 25 April 2020;

8. The valid PPC is represented by the certificate from flight safety Textron Aviation Training, PIC proficiency check was expiring on 7 May, 2020;

9. Proficiency check for unusual attitude recovery Simulator exercise was not found in PIC grade slip;

10. The aircraft was issued the initial Certificate of Airworthiness on 26 October 1986; the last Certificate of Airworthiness was reissued on 29 October 2019 with an expiry date of 30 October 2020.

11. The accident aircraft (ZS-CAR) was not maintained in accordance with regulation Part 43.02.8 whereby the FDR annual inspection was not conducted. Therefore, at the time of the accident, the Certificate of Airworthiness was rendered invalid;

12. The aircraft had been issued with a Certificate of Release to Service on 31 May 2019 with an expiry date of 31 May 2020 or 10227.7 airframe hours, whichever occurs first;

13. The aircraft was being operated under CAR 2011 Part 135, 171 was conducting an ILS calibration at the time of the accident;

14. The operator had been issued with an air operating certificate(AOC) number: CAA/G599Don 01 March 2019 with an expiry date of 28 February 2020;

15. The South African AIID and FIU structured under the SACAA;

16. The PIC was considered as chief pilot and manager operation;

17. The PIC was designated by FIU in the case of line checks;

18. The aircraft experienced three incidents in the past twelve months namely: On 2 March 2019, engine No 1 throttle did not respond due to a damaged throttle cable. In the month of November 2019, the aircraft had two incidents of an oil smell and smoke in the cockpit that resulted in the operator and AMO electing to change engine No 1. Following the incident of 8 November 2019, the aircraft remained on the ground until 17 January 2020;

19. The ELT automatically activates during a crash and transmits the standard swept tone on 121.5

and 243.0 MHz It also transmits a 406 MHz encoded digital message to the COSPAS/SARSAT satellite system, which allows first responders to quickly and accurately identify not only where you are, but who you are as well, however there was no signal received from the emergency locator transmitter (ELT) on channel 121.5 MHz frequency following the accident (as watched by ATC);

20. The accident aircraft was located by search and rescue within an hour after it was reported missing by the George Airport;

21. According to the FIU operations manual, the ILS calibration process should be carried out at 35° on either side of the runway centre line while maintaining 17NM DME arc. The height for the operation requires a flight at 2000ft AGL or obstacle plus 1000ft;

22. According to the FIU operations manual ILS operation was to perform a flight at 2000ft AGL or obstacle plus 1000ft, and the accident aircraft climbed to an altitude of 3900ft;

23. The last scheduled phase inspection was Phase 15, which was carried out on 13 August 2019 at 10035.0 airframe hours and there was no unscheduled maintenance during Phase 15 inspection. The aircraft had accumulated an additional 75 airframe hours in operation since the last phase check maintenance;

24. The AMO that carried out the last maintenance inspection on the accident aircraft was issued with an AMO approval certificate on 31 October 2019 with an expiry date of 31 October 2020;

25. The aircraft was not fitted with a CVR nor was it a requirement according to CAR 2011, Sub-Part 135.05.11 read together with SA-CATS 135.05.11;

26. Due to CAR 2011, Sub-Part 135.05.11 regulation not requiring the installation of the cockpit voice recorder (CVR) on the accident aircraft, the investigation team was unable to determine ifTAWS was operational at the time of the accident;

27. The aircraft was fitted with FDR which was downloaded in France under the supervision of a RSA- IIC;

28. According to available graph FDR results, as the aircraft leveled off at 3900ft (QNH 1018), a rapid descent occurred, and the aircraft lost 1500ft in approximately 9 seconds;

29. Where the aircraft at an altitude of 2400ft indicating that the aircraft was in a moderate recovery from a dive and low altitude, three seconds prior to impact, the aircraft nose pitch up increased from -32.5^0 to -17.5 degrees on a nose low attitude before impacting the terrain at 2192ft;

30. From FDR analysis, the crew may have entered to a characteristic of unusual attitude before

commencing calibration flight and unable to come out from suspected unusual attitude;

31. The aircraft was equipped with TAWS, which provides a warning to the flight crew when approaching close to terrain. However, due to the regulation not requiring the fitment of the CVRto this aircraft, the investigation team was unable to determine if TAWS was operational at the time of the accident;

32. The FDR recording capacity was limited by the aircraft system and it was not possible to validate additional parameters, because the aircraft was only triggered with limited parameters;

33. The operator did not conduct an annual FDR download on 8 January 2019 and 8 January 2020; as such, the operator was not in compliance with CAR Part 135.05.9 read together with SA-CATS 135.05.9 (4);

34. The ZS-CAR was returned to service on 17 January 2020 following serious incident that led to the damage of Class 1 component (Engine) and there were no records whether the aircraft was inspected prior to return to service as required by CAR Part 43.02.7 (6).This was in contravention of CAR Part 43.02.7 (6);

35. The installed FDR did not record **nine (9) mandatory parameters** required by CAR Part 135.05.9read together with SA-CATS 135.05.9, the operator did not conduct an annual mandatory inspection of the FDR and this was in contravention of CAR Part 135.05.9;

36. The ZS-CAR was installed with the FDR that did not meet the requirements of CAR Part **135.05.9** (1) and (2), therefore, the operator was in contravention of CAR Part 135.05.9;

37. The ZS-CAR FDR annual inspection was not carried out, and the operator was in contravention of CAR Part 43.02.8 and CAR Part 135.05.9;

38. The FIU did not have a compliance officer and that was in contravention of CAR Part 171.01.2(1) (a);

39. Further evidence records show that the FIU Part 171 ESO approval had expired in 01 April, 2019 and they were only reissued with the approval on 5 November 2019.The FIU continued to provide electronic services (calibration of navigational aid) between April 2019 and 4 November 2019 without an approval, and this was in contravention of CAR Part 171.01.2 (1);

40. Based on the information provided by SAWS, at the time of the accident the mountain tops were obscured by clouds;

41. At the time of approach to FAGG the weather condition around the area was inclement; therefore they were not cleared to conduct VOR calibration. As a result, they decided to land

and refuel the aircraft before commencing with the calibration of the Instrument Landing System (ILS) on Runway RWY 11 at FAGG;

42. The elevation of the mountain which the aircraft impacted was at 2192ft at GPS co-ordinates 33°55'24" South, 22°06'30" East. According to the wreckage debris, the impact corresponded with the aircraft being at a shallow dive angle on an upslope terrain;

43. At 08:46:10 ATC advised that ZSCAR will be outside the TMA, to broadcast 124.2 for traffic below the TMA;
44. FAGG was operating under VFR by day at the time of the accident;

45. The aircraft was destroyed during the impact and all three occupants were fatally injured;

3.2 Probable Cause

The crew lost control of the aircraft which resulted in significant loss of altitude; as they attempted to recover, they collided with the mountain. According to the SAWS report, there was significant cloud coverage below 1500 ft above ground level at the time of the accident as observed in the METARs. Mountain tops were obscured as seen on the Webcam. The aircraft route which is 17 N.M arc passes over the obscured mountains. From the limited FDR reading the aircraft attitude drastically changed into an unusual attitude when approaching the mountain area .This indicates that most probably, the pilot has entered into an unusual attitude during transition from VFR to IFR flight without preparation. The accident flight plan was VFR.

3.3 Contributing Factor

1. The presence of low clouds at about 1500ft below above ground and obscured mountains with clouds;
2. The incapability of the crew to recover from unusual attitude; lack of supervision and disregard of the Civil Aviation Regulations requirements by the FIU (operator).

3. Overbanked and steep dive maneuver, unable to gain the required altitude before impact;
4. Lack of upset prevention and recovery technique (UPRT);

4. SAFETY RECOMMENDATION

The aircraft was not equipped with CVR and unable to record TAWS warnings during impact to terrain and other necessary communications between crew;

The AAIB recommends: that the SACAA considered installing CVR on aircraft flying forcalibration purposes and other flights;

The FDR recording capacity was limited by the aircraft system and was not fit to record all required parameters for the accident aircraft;

The AAIB recommends: SACAA to ensure that operators install FDR's that record all mandatory parameters as required by the regulations. (eg. Part 135.05.10)

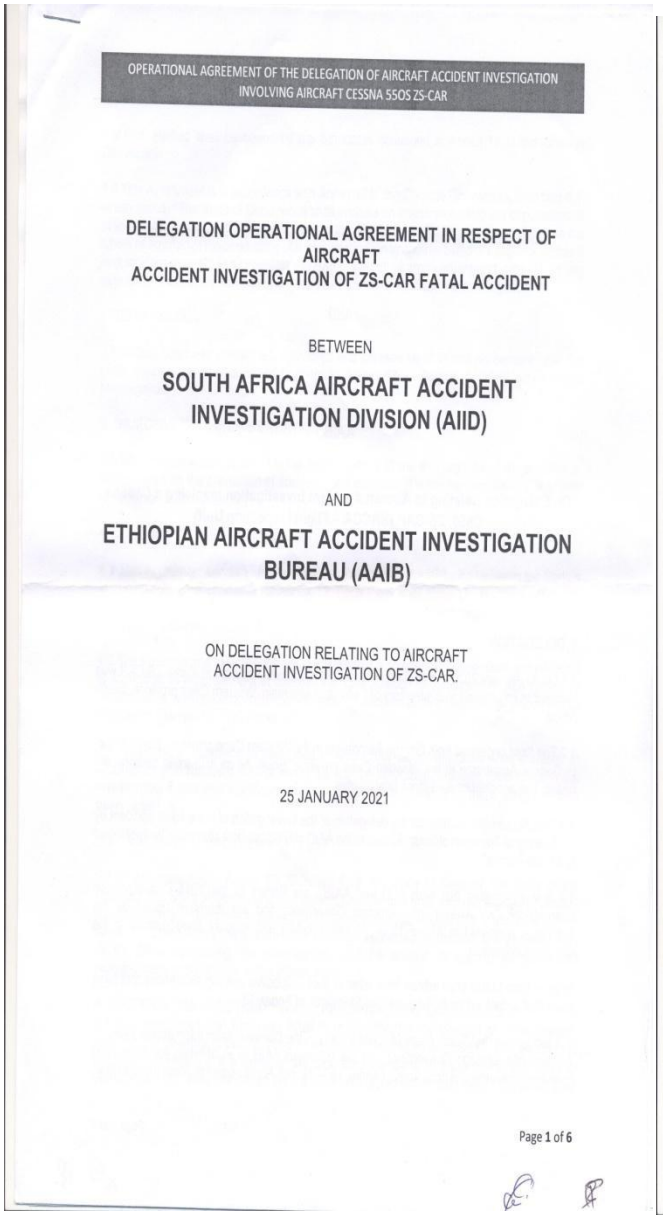
The South African AIID is established under the SACAA with ministerial order consent and at the same time the FIU is also under the authority;

The AAIB recommends: the South African AIID should be an independent from State aviation authorities and other entities that could interfere with the conduct or objectivity of an investigation and conflict of interest;

FIU operation manual instructs the crew to fly IFR for all operations;

The AAIB recommends: The SACAA to conduct an in-depth review of FIU operations to ensure that the operator complies with the regulatory requirements; crew should be proficient in unusual attitude recovery according to the regulation.

Appendixes



OPERATIONAL AGREEMENT OF THE DELEGATION OF AIRCRAFT ACCIDENT INVESTIGATION INVOLVING AIRCRAFT CESSNA 550S ZS-CAR

DELEGATION OPERATIONAL AGREEMENT IN RESPECT OF AIRCRAFT
ACCIDENT INVESTIGATION OF ZS-CAR FATAL ACCIDENT

BETWEEN

SOUTH AFRICA AIRCRAFT ACCIDENT INVESTIGATION DIVISION (AIID)

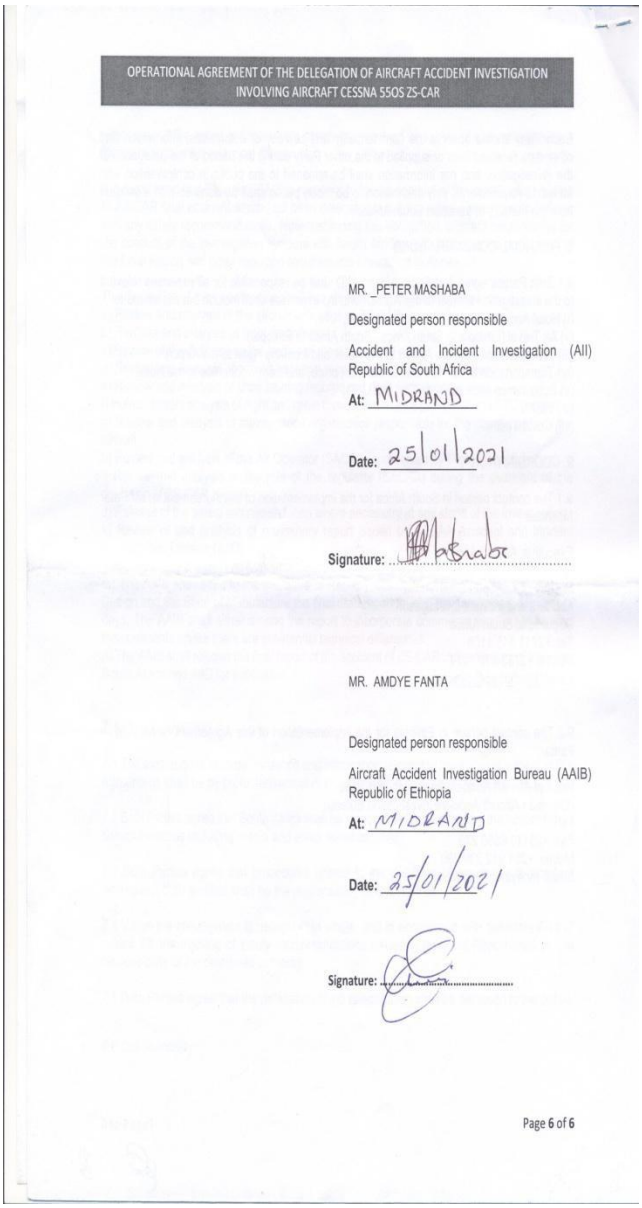
AND

ETHIOPIAN AIRCRAFT ACCIDENT INVESTIGATION BUREAU (AAIB)

ON DELEGATION RELATING TO AIRCRAFT ACCIDENT INVESTIGATION OF ZS-CAR.

25 JANUARY 2021

Page 1 of 6



OPERATIONAL AGREEMENT OF THE DELEGATION OF AIRCRAFT ACCIDENT INVESTIGATION INVOLVING AIRCRAFT CESSNA 550S ZS-CAR

MR. _PETER MASHABA

Designated person responsible

Accident and Incident Investigation (AII)
Republic of South Africa

At: MIDRAND

Date: 25/01/2021

Signature: .....

MR. AMDYE FANTA

Designated person responsible

Aircraft Accident Investigation Bureau (AAIB)
Republic of Ethiopia

At: MIDRAND

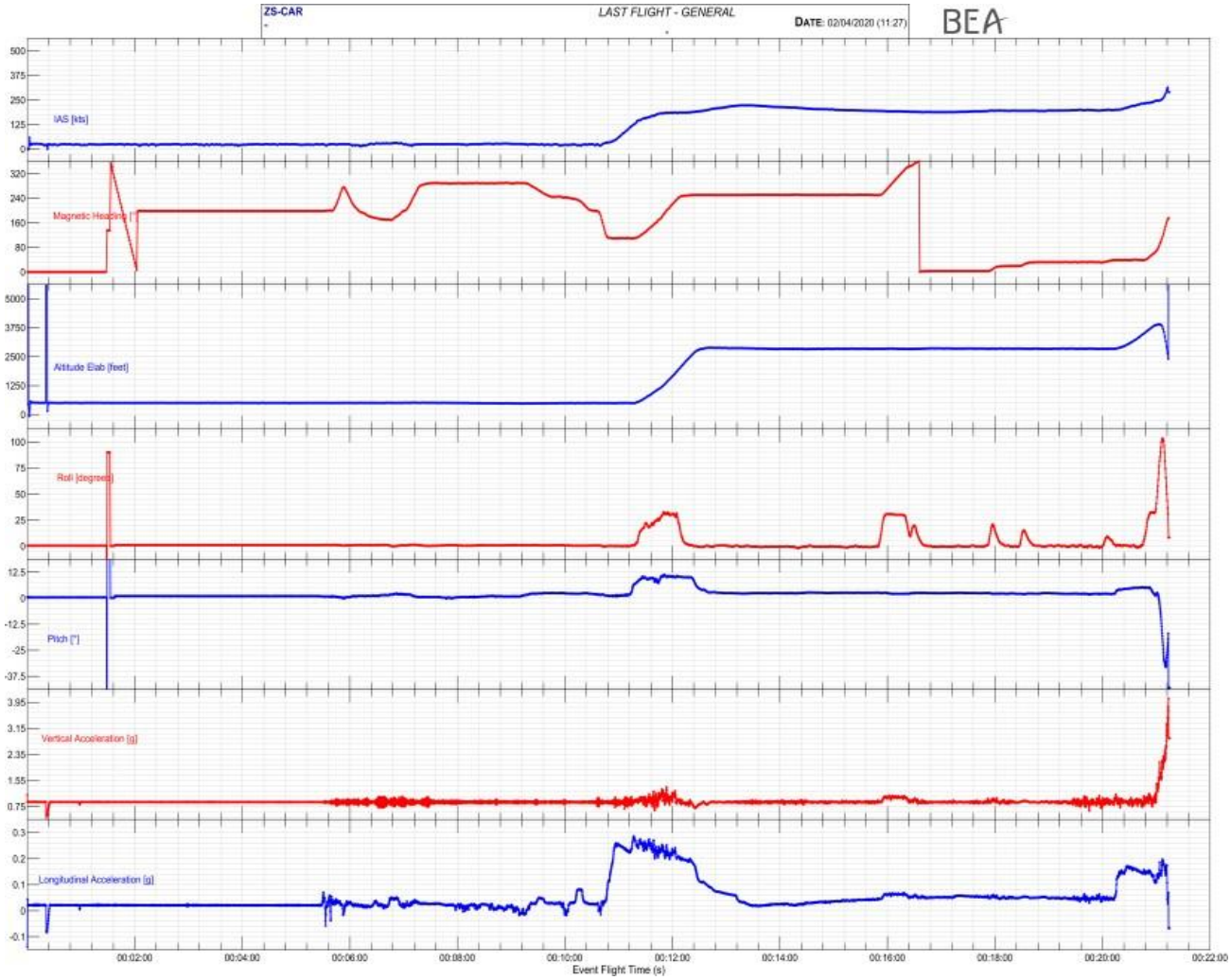
Date: 25/01/2021

Signature: .....

Page 6 of 6

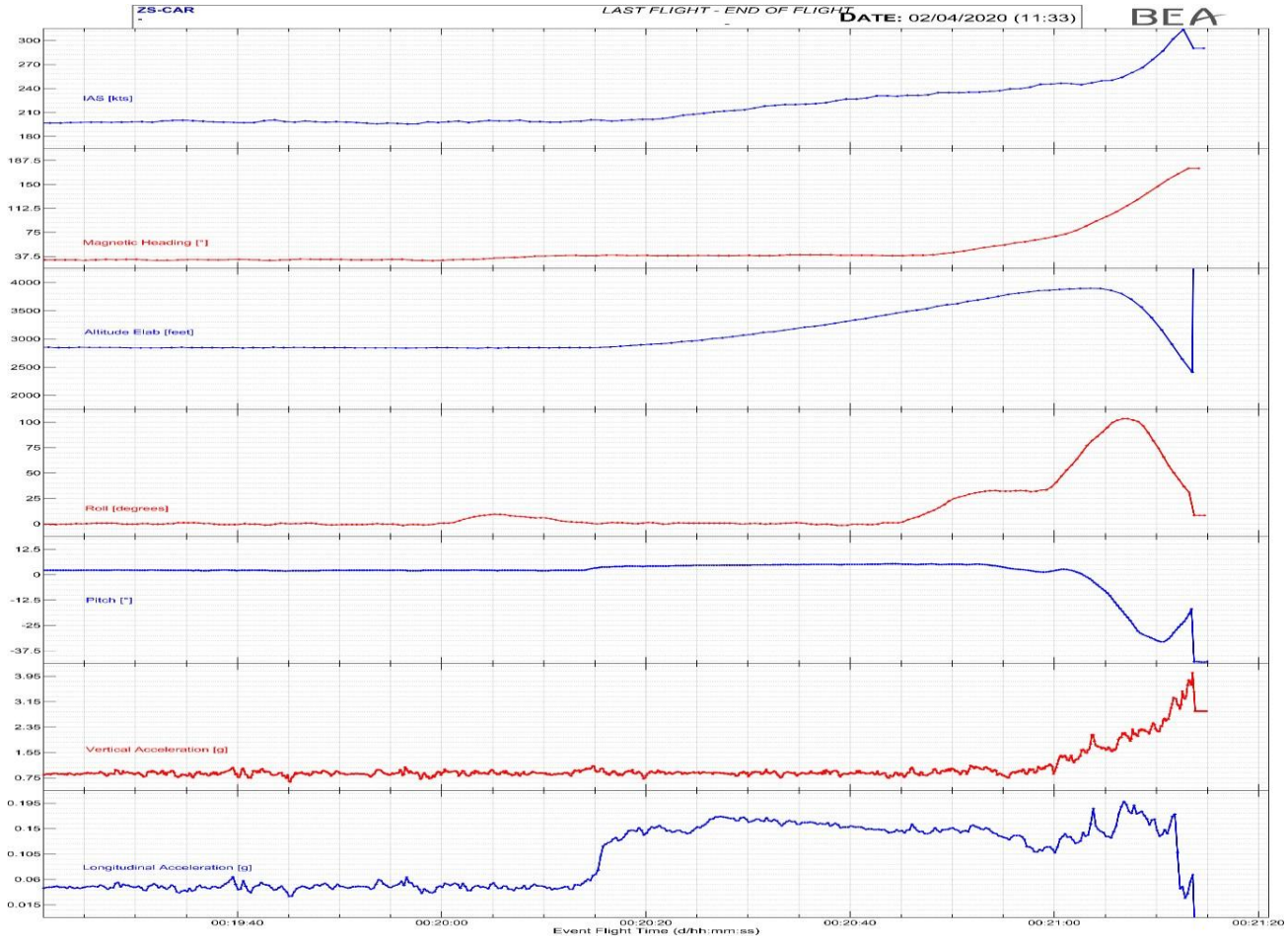
1. APPENDIX: A COMPILED MOU

2. Appendix: B General View of the FDR Analysis

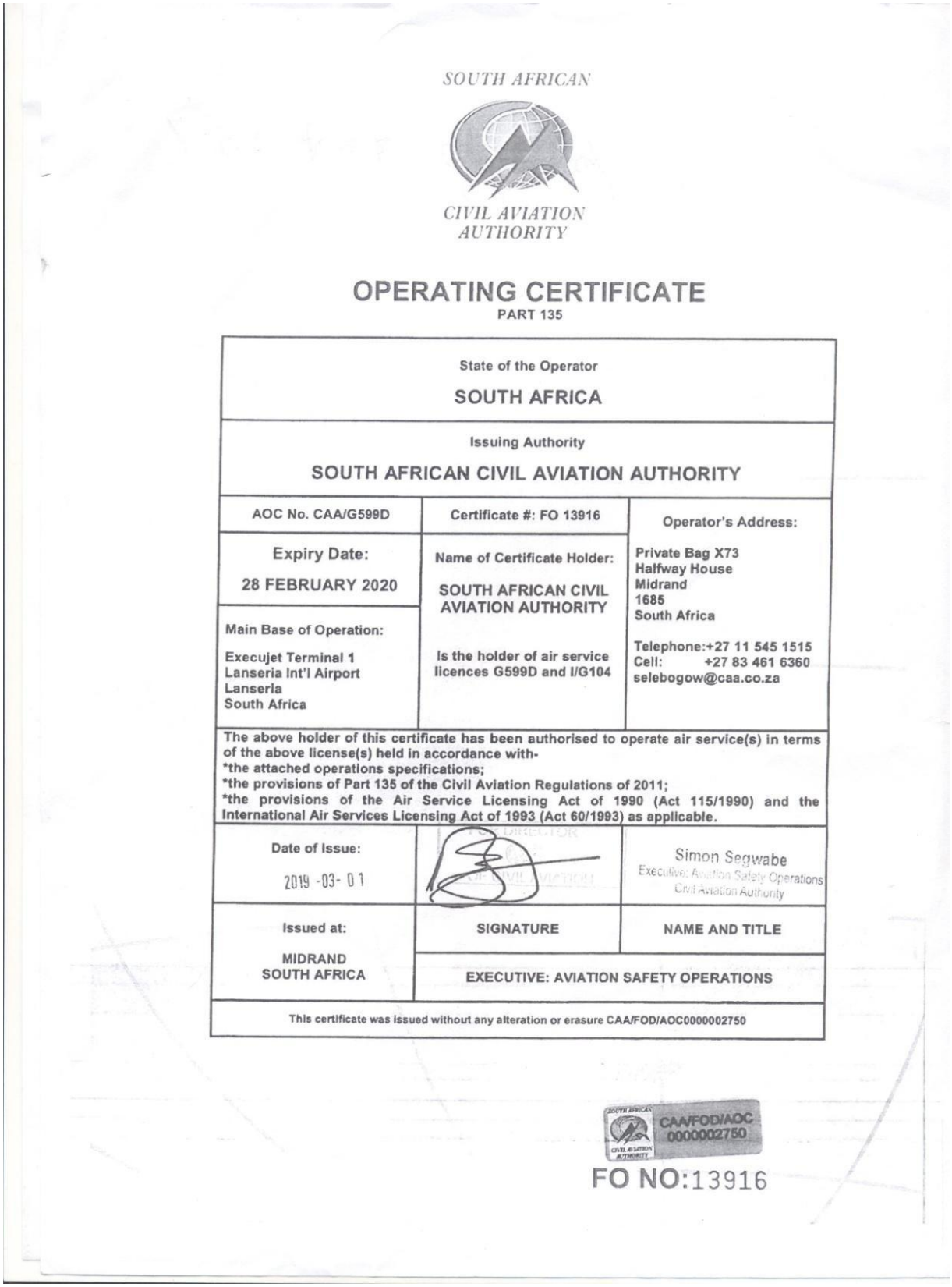


Appendix: B General View of the FDR Analysis

3. Appendix: C Last Flight View



Appendix: C Last Flight View



SOUTH AFRICAN
CIVIL AVIATION AUTHORITY

OPERATING CERTIFICATE

PART 135

State of the Operator **SOUTH AFRICA**		
Issuing Authority **SOUTH AFRICAN CIVIL AVIATION AUTHORITY**		
AOC No. CAA/G599D	Certificate #: FO 13916	Operator's Address:
Expiry Date: 28 FEBRUARY 2020	Name of Certificate Holder: SOUTH AFRICAN CIVIL AVIATION AUTHORITY	Private Bag X73 Halfway House Midrand 1685 South Africa Telephone:+27 11 545 1515 Cell: +27 83 461 6360 selebogow@caa.co.za
Main Base of Operation: Execujet Terminal 1 Lanseria Int'l Airport Lanseria South Africa	Is the holder of air service licences G599D and I/G104	
The above holder of this certificate has been authorised to operate air service(s) in terms of the above license(s) held in accordance with- *the attached operations specifications; *the provisions of Part 135 of the Civil Aviation Regulations of 2011; *the provisions of the Air Service Licensing Act of 1990 (Act 115/1990) and the International Air Services Licensing Act of 1993 (Act 60/1993) as applicable.		
Date of Issue: 2019 -03- 01		Simon Segwabe Executive: Aviation Safety Operations Civil Aviation Authority
Issued at: MIDRAND SOUTH AFRICA	SIGNATURE	NAME AND TITLE
	EXECUTIVE: AVIATION SAFETY OPERATIONS	
This certificate was issued without any alteration or erasure CAA/FOD/AOC0000002750		

CAA/FOD/AOC 0000002750

FO NO:13916

4. Appendix: D Operating Certificate Part 135

SOUTH AFRICA
CIVIL AVIATION

CIVIL AVIATION REGULATIONS, 2011, AS AMENDED (CARs)

ELECTRONIC SERVICES ORGANISATION
CERTIFICATE OF APPROVAL

1. Approval number:	**F171/001/19**	2. Expiry date:	**October**	**2020**
3. Type of Approval:	**CNS ESO Cat F (Flight Inspection Service of Air Navigation Systems)**			
4. Name of holder:	**SACAA-Flight Inspection unit (FIU)**			
5. Physical address of holder:		6. Postal address of holder:		
Execujet Terminal Lanseria International Airport Lanseria		Private Bag X 73 Halfway House 1685		

7. Scope of approval:

It is hereby stated that the SACAA Flight Inspection Unit has met the minimum requirements for provision of Flight Inspection Services of the following Air Navigation system in accordance to Part 171 CARs and CATS:

- ILS (CAT I,II,III)
- VOR (CVOR and DVOR)
- DME/TACAN
- NDB
- PAPI lights
- GNSS

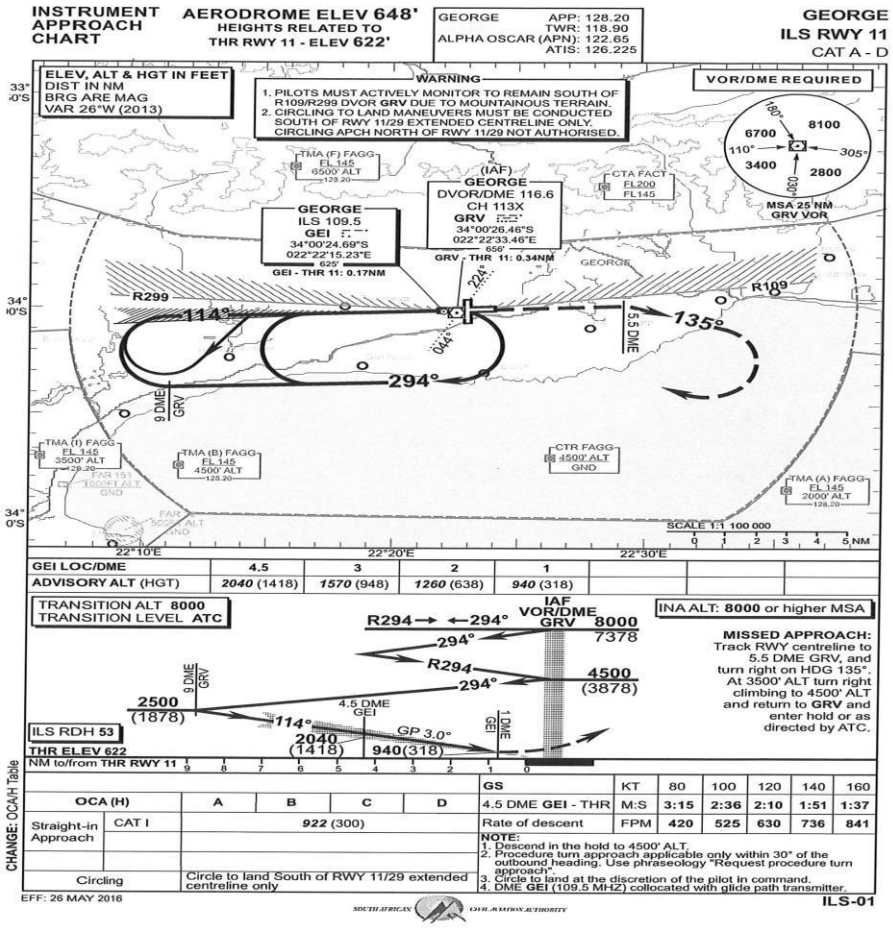
8. I hereby certify that the holder of this approval has been duly approved in accordance with Part 171 of the CARs.

	Gawie Bestbier	5/11/2019
SIGNATURE OF AUTHORISED PERSON: CIVIL AVIATION AUTHORITY	**NAME IN BLOCK LETTERS**	**DATE OF ISSUE**

CA 171-C-003	***28 June 2018***	Page 1 of 1

5. Appendix: E Certificate of Approval

6. Appendix: F FAGG Radar Terrain Clearance Chart



7. APPENDIX: G PART 135.05.11

1.11.3 The requirement for a CVR is stipulated in the CARs part 135.05.11:

Cockpit voice recorders

135.05.11 (1) An air service operator shall ensure the airplanes specified in Document SA-CATS 135, when operated in terms of this part, are equipped with the CVR specified in Document SA-CATS 135 and that such CVR complies with the specifications prescribed therein.

(2) The CVR shall record, with reference to a time scale—

(a) voice communications transmitted from or received on the flight deck or in the cockpit by radio;

(b) the aural environment of the flight deck or cockpit, including without interruption, the audio signals received from each microphone in use;

(c) voice communications of flight crew members on the flight deck or in the cockpit using the interphone system of the airplane, if installed;

(d) voice or audio signals identifying navigation or approach aids introduced into a headset or speaker; and

(e) voice communications of flight crew members on the flight deck or crew members in the cockpit using the public address system of the airplane, if installed.

(3) The CVR shall—

(a) be capable of retaining information recorded during at least the period of time as prescribed in Document SA-CATS 135;

(b) start automatically to record the airplane moving under its own power and continue to record, until the termination of the flight when the airplane is no longer capable of moving under its own power; and

(c) if possible, start to record the cockpit checks prior to engine start at the beginning of the flight, until the cockpit checks immediately following engine shutdown at the end of the flight.

(4) The CVR may be combined with FDR referred to in regulation 135.05.11.

The requirement for a CVR is stipulated in the SACATS Sub-Part 135.05.11:

Cockpit voice recorders

The aircraft was not required to be equipped with a CVR because the aircraft was registered in 1986. (Refer to table below)

Group See note 1.	**Conditions See note 2.**	**Maximum Certificated Take-Off Mass (kg)**	**Propulsion System**	**Recording retained for the last 30 minutes of operation**	**Recording retained for the last 2 hours of operation**	**Recording retained for at least the last 25 hours of operation**
1	Application for type certification submitted to Contracting State on or after 1 January 2016 and required to be operated by more than one pilot	> 2250 but ≤ 5700	Turbine		X	
2	Individual certificate of airworthiness first issued on or after 1 January 2003	> 5700	All		X	
3	Individual certificate of airworthiness first issued on or after 1 January 1987	> 5700	All	-	X	
4	Individual certificate of airworthiness first issued before 1 January 1987 whose types of which the prototype was certificated by the appropriate national authority after 30 September 1969	> 27000	Turbine	-	X	
5	individual certificate of airworthiness is first issued on or after 1 January 2021	> 27000	All			X

8. Appendix: H FIU Application for Part 171 Approval

SOUTH AFRICAN CIVIL AVIATION AUTHORITY

Section/division: COMMUNICATION, NAVIGATION AND SURVEILLANCE — Form Number : CA 171-05
Telephone number: 011-545-1000 Fax Number: 011-545-1282
Physical address: Ikhaya Lokundiza, 16 Treur Close, Waterfall Park, Bekker Street, Midrand, Gauteng
Postal address: Private Bag X73, Halfway House 1685 Website: www.caa.co.za

DETAILS OF BANK ACCOUNT FOR PAYMENT OF PRESCRIBED FEE			
Bank: Standard Bank of SA Ltd	Branch: Brooklyn, Pretoria	Branch Code: 011245	Account Number: 013007971

COMPULSORY CLIENT PAYMENT CODE (to be completed on deposit slip)		
Service/transaction	Over the counter payments	EFT, Internet, Wire, Electronic payments
ESO APPROVAL / Fees: See CAR Part 187.XX.XX		

APPLICATION FOR ISSUE /AMENDMENT /RENEWAL OF ESO APPROVAL

Note: The application shall be accompanied by the appropriate fee as prescribed in Part 187 of the CARs and the Manual of Procedures referred to in regulation 171.03.1

PART 1: PARTICULARS OF THE APPLICANT

Name and address of person or organisation applying for approval

Full name:	SACAA Flight Inspection Unit (FIU)
Trade name:	South African Civil Aviation Authority

Legal status of applicant/holder (individual/close corporation/company/trust/other – specify):

Registration number:	See attached letter				
Business address:	Execujet Terminal, Lanseria International Airport, Lanseria			Postal code:	1748
Postal address:	P.O Box 1050, Lanseria			Postal code:	1748
Tel No	011 659 2263	Fax No	—	e-mail:	selebogow@caa.co.za

Full particulars in respect of the individual/each responsible director/shareholder/partner/member/office bearer:

Name	Position	Identity number	Nationality	Country of permanent residence
	N/A			

Name and address of person to whom enquiries should be addressed if different to the above:

Name:	Ketlareng William Selebogo				
Postal address:				Postal code:	
Tel No		Fax No		e-mail:	

PART 2: PARTICULARS REGARDING THE APPROVAL

Note: Approval number and expiry date are to be filled in for amendment and renewal of approvals

Name of ESO	South African Civil Aviation Authority - Flight Inspection Unit (FIU)		
Approval number:	ESO-F003	Expiry date:	01 April 2019

Type of application: **(Indicate with an X)**

Issuing of ESO approval		Amendment of ESO approval		Renewal of ESO approval	X

List type of facilities applied for: **(Use a separate page if space provided is not enough)**

1. ILS (All Categories)	6. PAPI Lights
2. VOR (CVOR and DVOR)	7. GNSS
3. DME	8.
4. TACAN	9.
5. NDB	10.

The applicant/holder declares hereby that the particulars provided in this application are true in every respect:		
	K. W Selebogo	31 October 2019
SIGNATURE OF APPLICANT	NAME IN BLOCK LETTERS	DATE

PART 3: FOR CAA OFFICIAL USE ONLY		
Receipt number:		
SIGNATURE OF AUTHORISED OFFICER	NAME IN BLOCK LETTERS	DATE

SOUTH AFRICAN CIVIL AVIATION AUTHORITY

Physical Address: Ikhaya Lokundiza, Treur Close, Waterfall Park, Bekker Street, Midrand
Postal Address: Private Bag X 73, Halfway House, 1685
Telephone Number: +27 11 545 1000
Fax Number: +27 11 545 1465
E-mail Address: mail@caa.co.za
Website Address: www.caa.co.za
Southern Region Office: PO Box 174, Cape Town International Airport
Tel. Number: +27 21 934 4744
Fax Number: +27 21 934 1326

TO WHOM IT MAY CONCERN

LEGAL STATUS OF THE SOUTH AFRICAN CIVIL AVIATION AUTHORITY:

This serves to confirm the legal status of the South African Civil Aviation Authority as follows:

1. Company Registration Certificate:
   The South African Civil Aviation Authority (SACAA) a statutory body created in terms of Section 71 of the Civil Aviation Act No. 13 of 2009, as amended. It is a schedule 3A public entity in terms of the Public Finance Management Act, 1999 reporting to the National Department of Transport.

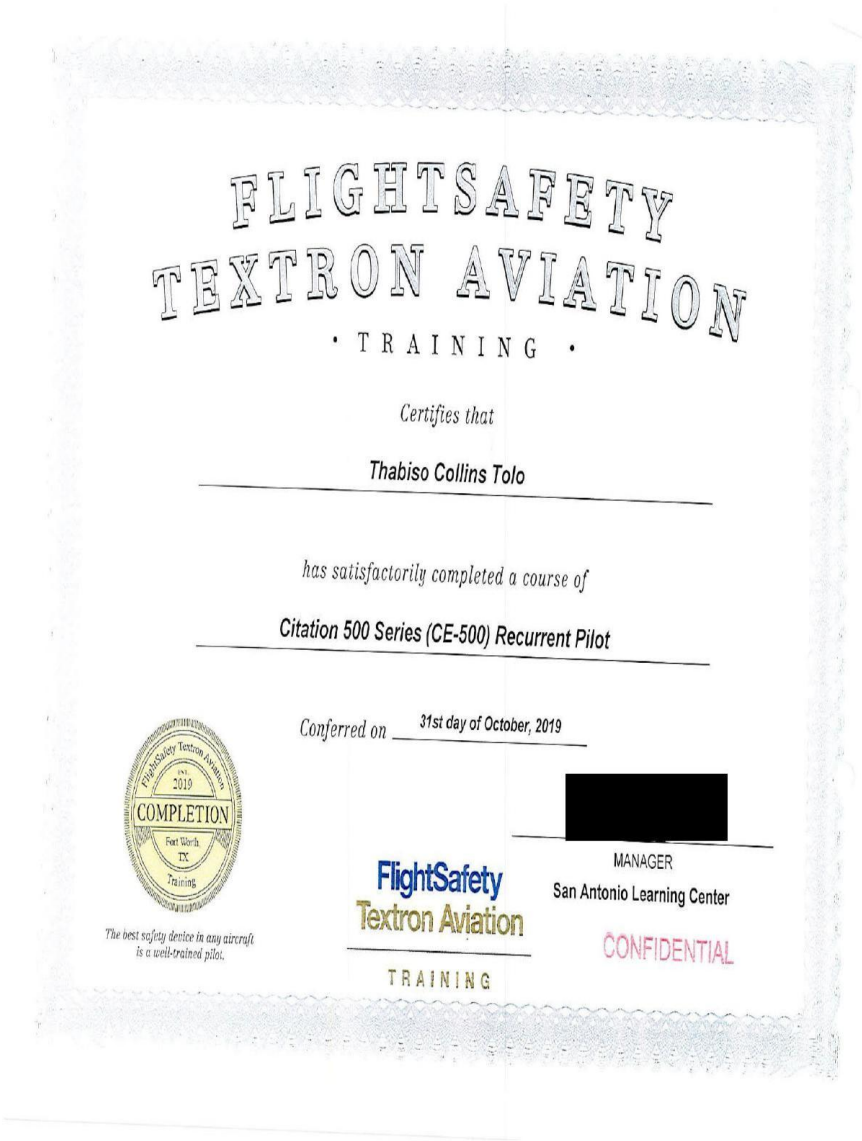
   SACAA is a juristic person and as the aviation regulator has its registered place of business at:
   Ikhaya Lokundiza Building 16, Treur Close
   Waterfall Park
   Bekker Street
   Midrand

2. Tax Clearance Certificate:
   The SACAA is tax exempt in South Africa and under the South African Law.

Yours faithfully

MS N NARAINDATH
COMPANY SECRETARY
SOUTH AFRICAN CIVIL AVIATION BOARD
DATE: 1 NOVEMBER 2019

Appendix: I Training Certificate



FLIGHTSAFETY
TEXTRON AVIATION
· TRAINING ·

Certifies that

Thabiso Collins Tolo

has satisfactorily completed a course of

Citation 500 Series (CE-500) Recurrent Pilot

Conferred on 31st day of October, 2019

FlightSafety Textron Aviation Est. 2019 COMPLETION Fort Worth TX Training

The best safety device in any aircraft is a well-trained pilot.

[redacted]
MANAGER
San Antonio Learning Center

FlightSafety
Textron Aviation
TRAINING

CONFIDENTIAL