AIRCRAFT SERIOUS INCIDENT REPORT AND EXECUTIVE SUMMARY

				Reference:	CA18/3/2/1291		
Aircraft Registration	ZS-CAR	**Date of Incident**	8 November 2019		**Time of Incident**	0720Z	
Type of Aircraft	Cessna 550		**Type of Operation**		Flight Calibration (Part 135)		
Pilot-in-command Licence Type	Airline Transport Pilot Licence		**Age**	48	**Licence Valid**	Yes	
Pilot-in-command Flying Experience	Total Flying Hours	5200			Hours on Type	1300	
Co-Pilot Licence Type	CPL	**Age**	**33**		Licence Valid	Yes	
Co-Pilot Flying Experience	Total Flying Hours	1046.4			Hours on Type	250.5	
Last Point of Departure	Lanseria International Airport (FALA), Gauteng Province						
Next Point of Intended Landing	Polokwane International Airport (FAPP), Limpopo Province						

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

On Runway 07 at FALA at the following GPS co-ordinates: S23°50'43.2" E029° 27'30.7" with an elevation of 4521ft AGL

Meteorological Information	Wind: 260º/ 3kt; Visibility: >10km; Cloud: Nil, QNH 1022				
Number of People On-board	2+2	**No. of People Injured**	0	**No. of People Killed**	0

Synopsis

On Friday morning, 8 November 2019, the Cessna 550 aircraft with registration ZS-CAR was scheduled to depart Lanseria International Airport (FALA) on a flight to Polokwane International Airport (FAPP). During the take-off roll on Runway 07, the crew became aware of an oil smell and smoke in the cockpit; the smoke also reduced forward visibility. The crew decided to abort take-off and applied maximum brakes. The aircraft stopped on the runway and was taxied back to the hangar where the engines were shut down. After parking the aircraft, the right main tyre deflated and, minutes later, the left main tyre also deflated because of the temperature fuse plugs that had melted. The crew did not sustain any injuries during the serious incident, except for slight discomfort due to smoke inhalation, as well as a burning sensation in their eyes.

The investigation revealed that during the take-off roll, the crew experienced an oil smell and smoke in the cockpit as a result of the number 3 bearing labyrinth seal failure of engine number 1. This caused the oil to leak into the high-pressure compressor (HPC) where the oil mixed with compressed and heated air, resulting in the oil smell and smoke in the cockpit.

Contributory factors:

- The aircraft maintenance organisation (AMO) and the operator were not monitoring the oil consumption of the number 1 engine
- The aircraft maintenance engineer (AME) misdiagnosed the defect as a result of not complying with the manufacturer's recommended practise
- The operator and the AMO's non-compliance of safe and standard recommended practises by the manufacturer and the Civil Aviation Regulations

SRP Date	13 October 2020	Publication Date	21 October 2020

ABBREVIATION	DESCRIPTION
ACM	Air Cycle Machine
AME	Aircraft Maintenance Engineer
AMO	Aircraft Maintenance Organisation
AMSL	Above Mean Sea Level
AOC	Air Operating Certificate
ATC	Air Traffic Control
ATNS	Air Traffic and Navigation Services
ATPL	Airline Transport Pilot Licence
C of A	Certificate of Airworthiness
C of R	Certificate of Registration
CAA	Civil Aviation Authority
CAVOK	Ceiling and Visibility OK
CAR	Civil Aviation Regulations
CVR	Cockpit Voice Recorder
DME	Distance Measuring Equipment
FALA	Lanseria International Airport
FAWB	Wonderboom Airfield
FAPP	Polokwane International Airport
FIU	Flight Inspection Unit
FDR	Flight Data Recorder
ft	feet
GND	Ground
IAW	In Accordance With
ILS	Instrument Landing System
kt	Knot
LOC	Localiser
METAR	Meteorological Aeronautical Report
MM	Maintenance Manual
N1	Low Pressure Compressor Speed
NORM	Normal
PIC	Pilot-in-command
QNH	Query: Nautical Height
QRH	Quick Reference Handbook
RPM	Revolutions Per Minute
SAWS	South African Weather Service
UHF	Ultra-High Frequency
VHF	Very High Frequency
Z	Zulu (Term for Universal Coordinated Time - Zero hours Greenwich)

Reference Number	**:** CA18/3/2/1291
Name of Owner	**:** South African Civil Aviation Authority (SACAA)
Name of the Operator	**:** SACAA Flight Inspection Unit
Manufacturer	**:** Cessna Aircraft Company
Model	**:** C550
Nationality	**:** South African
Registration Marks	**:** ZS-CAR
Place	**:** Lanseria International Airport (FALA)
Date	**:** 8 November 2019
Time	**:** 0720Z

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

Purpose of the Investigation:

In terms of Regulation 12.03.1 of the Civil Aviation Regulations (CAR) 2011, this report was compiled in the interest of the promotion of aviation safety and the reduction of the risk of aviation accidents or incidents and ***not to apportion blame or liability****.*

Investigations Process:

The serious incident was notified to the Accident and Incident Investigations Division (AIID) on 8 November 2019 at about 0900Z. The investigators went to Lanseria International Airport (FALA) on 12 November 2019 for a follow up investigation. The investigators co-ordinated with all authorities at FALA by initiating the accident investigation process according to CAR Part 12 and investigation procedures. The AIID is leading the investigation as the Republic of South Africa is the state of occurrence.

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

Incident – this investigated serious incident
Aircraft – the Cessna 550 involved in this serious incident
Investigation – the investigation into the circumstances of this serious incident
Pilot – the pilot involved in this serious incident
Report – this serious incident report

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

Disclaimer:

1. FACTUAL INFORMATION

1.1 History of Flight

1.1.1 On Thursday, 7 November 2019, a Cessna 550 aircraft with registration ZS-CAR executed a missed approach at Wonderboom Airport (FAWB) and diverted to Lanseria Airport (FALA) because of an oil smell and smoke in the cockpit, which was coming in through the air vents. The crew landed safely at FALA.

1.1.2 The crew entered a defect in the flight folio number 679674, stating that there was smoke in the cockpit. The AMO/AME conducted an inspection of both engines, thereafter, indicated that there was no visible oil on the dipstick of the number 1 engine; and thus, they added three cans of oil to rectify the problem. The number 2 engine only needed to be topped up with one can of oil. Following a maintenance procedure, which included a ground run on both engines, the defect was accordingly signed out in the flight folio and work pack before returning the aircraft to service.

1.1.3 On Friday morning, 8 November 2019, Lanseria International Airport (FALA) air traffic control (ATC) reported that the aircraft was scheduled for ground navigational instrument calibration at Polokwane International Airport as stated in the flight folio number 67975. The start-up and taxi were uneventful. However, during the take-off roll on Runway 07 at FALA, the crew again experienced an oil smell and smoke which filled the cockpit and obstructed their forward visibility. The crew decided to abort take-off by applying maximum brakes. The aircraft was taxied back to the hangar where the engines were shut down. After the aircraft was parked, the right main tyre deflated and, minutes later, the left main tyre also deflated. Both tyres deflated because of the temperature fuse plugs that had melted. The crew sustained no injuries and the aircraft was not damaged.

1.1.4 On Monday 25 November 2019 a new oil scavenging pump was fitted onto the left-hand engine and tested by maintenance as per the AMO maintenance ground run to confirm correct operation of the engine. They crew then requested a test flight.

1.1.5 During an interview with the (AME), he stated the following:

- On 19 July 2019, after the aircraft had returned from its mission, the crew reported that the engine oil on the number 1 engine had lowered slightly and some residual oil was evident in the cowling area. The crew also requested that the engine gets a compressor wash. The AME further reported that the work was performed as requested by the crew, and that was followed by ensuring that there were no further requirements or issues.

- On 7 November 2019, the aircraft had returned from its mission as stated in flight folio 679674 and the crew had been monitoring the engines oil as discussed with them. The crew asked for another compressor wash on the number 1 engine, as well as a thorough engine visual inspection. The AME completed the task as

required and, again, checked all components as per the inspection criteria with no visual issues or further requirements.

- On 26 November 2019, the aircraft attempted to depart from FALA with the intention to return to FALA as stated in the flight folio 68400 when the crew executed an aborted take-off. The crew reported to the AME that there was evident smoke in the cockpit which was an immediate concern. The AME then conducted a borescope inspection and took a soap/oil sample.

- On 29 November 2019, the aircraft attempted to depart from FALA with the intention to return to FALA as stated in the flight folio 67951 and, following the pre-take-off runs at the holding point of Runway 07, the crew noted that there was still smoke in the cockpit and cabin, and elected to return to the AMO.

- The maintenance manager, after realising that the problem was not being resolved, opted to have the AME and the crew during the ground run to simulate the fault. They taxied the aircraft to the holding point for a ground run. During the ground run and as the AME could not simulate the fault, the captain selected the pressure source knob to “normal” mode and the smoke filled the cabin and cockpit. The AME requested that the captain select the pressure source knob back to the “ground” mode and the smoke started to wear off. The AME mentioned that he tested the system in “ground” mode as he had asked the captain to leave the aircraft in the same configuration as when he had experienced the smoke in the cockpit, and that was not done.

Figure 1: The arrow points at the pressure select knob. (Source http://www.scanav.com)

1.1.6 The serious incident occurred during daylight at FALA at the following Global Positioning System (GPS) co-ordinates: 25º56'22.89''S 027º55'32.07''E at an elevation of 4521 feet (ft) above ground level (AGL).

1.2 Injuries to Persons

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

1.3 Damage to Aircraft

1.3.1 Limited to the number 1 engine.

1.4 Other Damage

1.4.1 None.

1.5 Personnel Information

1.5.1 Pilot-in-command (PIC):

Nationality	South African	Gender	Male	Age	48
Licence Type	Airline Transport Pilot Licence				
Licence Number	0271036808				
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	Instrument; Instructor Grade 2				
Medical Expiry Date	31 October 2020				
Restrictions	None				
Previous Accidents	None* (Refer to paragraph 1.5.1.1)				

Total Hours	5200.0
Total Past 90 Days	60.0
Total on Type Past 90 Days	60.0
Total on Type	1300.0

1.5.1.1 Subsequent to this serious incident, the ZS-CAR aircraft was involved in a fatal accident on 23 January 2020, which occurred during the investigation of this serious incident.

1.5.1.2 The PIC was issued a Class 1 aviation medical certificate on 23 October 2019 with an expiry date of 31 October 2020.

1.5.2 First Officer (FO):

Nationality	South African	Gender	Female	Age	33
Licence Type	Commercial Pilot Licence				
Licence Number	0272459769				
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	Instrument				
Medical Expiry Date	30 September 2020				
Restrictions	None				
Previous Accidents	None				

Total Hours	1046.4
Total Past 90 Days	54.8
Total on Type Past 90 Days	54.8
Total on Type	250.5

1.5.2.1 The FO was issued a Class 1 aviation medical certificate on 26 September 2019 with an expiry date of 30 September 2020.

1.5.2.2 The Flight Inspection Unit (FIU) inspectors are tasked with operating the flight inspection system (a CANAC-30) fitted on-board (their) aircraft to calibrate ground navigation and approach systems.

Nationality	South African	Gender	Male	Age	32
Licence Type	Aircraft Maintenance Engineer				
Licence Number	0272438516				
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	BEECH 1900C; Cessna 208 Series; Cessna C550 Airframe				
Restrictions	None				
Previous Accidents	None				

1.5.3 The AME was initially issued an Aircraft Maintenance Engineer Licence on 12 November 2012.

1.6 Aircraft Information

1.6.1 The serious incident aircraft, a Cessna S550, was manufactured in 1986. The aircraft was fitted with two Pratt & Whitney Canada JT-15D-4 turbo fan engines. The aircraft was utilised by FIU to calibrate navigational and approach facilities. The aircraft was fitted with calibration equipment and seats in the passenger compartment to allow the inspector on-board to carry out the calibration function.

Airframe:

Type	Cessna 550	
Serial Number	S550-0078	
Manufacturer	Cessna Aircraft Company	
Date of Manufacture	1986	
Total Airframe Hours (At time of Incident)	10 090.7	
Last Inspection (Date & Hours)	21 August 2019	10031.1
Hours Since Last Inspection	59.6	
C of A (Issue Date)	28 October 1986	
C of R (Issue Date) (Present owner)	26 August 2010	
Operating Categories	Part 135 G16 (Flight Calibration of Navigation Aids)	

Engine No.1 (left-hand)

Type	JT15D-4
Serial Number	PCE-70925
Hours Since New	8 265.9
Hours Since Overhaul	1288.3

1.6.2 The Pratt & Whitney engine is a turbo fan engine. Its maximum oil consumption is 0.228 litres per hour under normal conditions. The operator and the AMO had no records which would indicate the monitoring of the engine oil consumption and they did not record the oil uplifts for both engines in the flight folio or in any other system.

1.6.3 On 27 May 2019, engine number 1 with part number JT15D-4B and serial number 102175, with 10012.2 hours was removed and replaced with the loaned engine with part number JT15D-4B and serial number PCE 70925, with 8094.6 hours after being checked and found serviceable. The engine accumulated 171.3 hours since its installation on the aircraft. All work was carried out in accordance with (IAW) Cessna Citation S550 M.M (maintenance manual) Chapter 71-00-00 20.

1.6.4 On 7 and 8 November 2019, the aircraft experienced two serious incidents of smoke and oil smell in the cockpit. The two engines (left- and right-hand) fitted on the aircraft were inspected. It was found that the number 1 engine needed to be filled with three quarts of oil, whereas the number 2 engine only needed to be filled with one quart of oil. The engines were replenished with oil, respectively; and a compressor wash as well as a visual inspection were carried out. A borescope inspection was carried out on the number 1 engine on 8 November 2019 after the serious incident of smoke and oil smell in the cockpit. The results indicated that there was a leak around the high-pressure (HP) impeller flutes and diffuser entry points, and there was presence of oil in the compressor section.

1.6.5 Subsequent to the serious incident under investigation, on 29 November 2019, the aircraft attempted to depart from FALA for its mission and, following the pre-take-off runs at the holding point of Runway 07, the crew noted that there was smoke in the cockpit and cabin, and elected to return to FALA for the aircraft to be checked again by the AMO.

1.6.6 The AMO conducted another borescope inspection on 29 November 2019 to inspect the internal components of the number 1 engine, with job card number T2143, by Turbine Engine Management Services (Pty) Ltd. The borescope inspection, once again, revealed that there was a leak around the HP impeller flutes and diffuser entry points and there was presence of oil in the HPC impeller. (See Figures 2 and 3)

Figure 2: The high-pressure compressor (HPC) / impeller blade with oil on it.

Figure 3: The HPC / impeller blade with evidence of oil on it.

1.6.7 Following the second borescope inspection results, the maintenance organisation and the operator took a decision to remove the defective number 1 engine from the aircraft ZS-CAR and the defective engine was shipped to the manufacturer to establish the cause of the oil leak and the presence of oil in the HPC impeller.

1.6.8 The AMO and the operator attempted to resolve the serious incident of smoke and oil smell in the cockpit from 7 November 2019 until 29 November 2019 when a decision was made to replace the defective engine.

Engine No.2 (right-hand)

Type	JT15D-4
Serial Number	102187
Hours since New	9889.7
Hours since Overhaul	Modular assembly

1.6.9 Following the overhaul of the left engine on 31 August 2011 at 7032.6 hours, it was refitted on the right side as the number 2 engine on 15 September 2011.

1.6.10 History of the number 2 engine removal and installation:

a. The number 2 engine (right position) was changed twice following a scheduled engine overhaul.

1.7 Meteorological Information

The weather information below was obtained from the Meteorological Aeronautical Report (METAR) issued by the South African Weather Service (SAWS) for FALA on 8 November 2019 at 0700Z.

Wind direction	260º	Wind speed	3 kts	Visibility	>10 km
Temperature	25˚C	Cloud cover	Nil	Cloud base	Nil
Dew point	11˚C	QNH	1022		

1.8. Aids to Navigation

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

1.9 Communication

1.9.1 The aircraft was equipped with standard communication equipment as approved by the Regulator for this aircraft type. There were no recorded defects prior to the serious incident. The crew was in communication with FALA air traffic control (ATC) on 124.0 megahertz (MHz).

1.10 Aerodrome Information

Aerodrome Location	Lanseria International Airport (FALA)
Aerodrome Co-ordinates	25°56'22.89" S 027°55'32.07" E
Aerodrome Altitude	4 521ft AMSL
Runway Headings	07/25
Runway Dimensions	2 996m x 45m
Runway Used	07
Runway Surface	Asphalt
Approach Facilities	UHF DME; ILS LOC; ILS/DME, Runway lights
Radio Frequency	124.0 FALA Tower

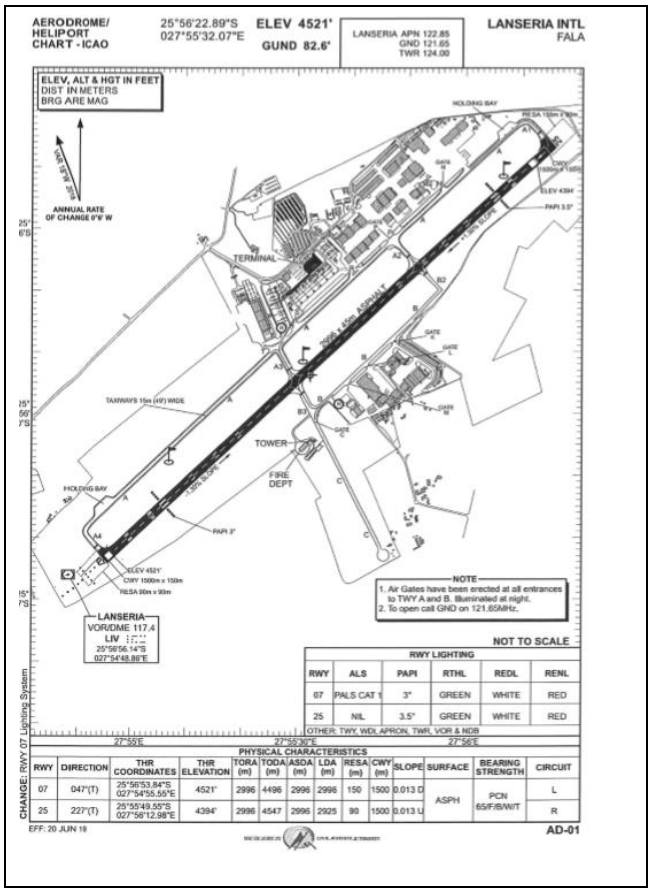


Figure 4: Plates of FALA.

1.11 Flight Recorders

1.11.1 The aircraft was fitted with a Fairchild F-1000 flight data recorder (FDR) on 8 January 2018 as required by the CAR 2011 Part 135.05.10. According to the documents received from the AMO and the operator, the FDR was last tested and the downloads conducted on 8 January 2018 by an approved AMO number 808 (see attachment G). However, the FDR test and download were never conducted on their due date in January 2019.

1.11.2 CAR 2011 Part 135.05.10 read together with the South African Civil Aviation Technical Standards (SA-CATS) 135.05.10(4) details 16 parameters for the type II FDR (see Appendix F).

1.11.3 The SA-CATS 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; but only the test was conducted, and not the download of the recorded data. As such, the operator did not comply with the requirements of SA-CATS Part 135.05.9(4)(2)(a).

SA-CATS 135.05.9(4). Inspections of flight recorders

(2) Annual inspections shall be carried out as follows –

(a) the read-out of the recorded data from the FDR and CVR 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;

(3) The results of the annual inspections shall be recorded and retained for a period of five years calculated from the date of such check.

(4) 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.

(5) When requested, a report of the annual inspection should be made available to the Director for monitoring purposes.

(6) 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;

1.11.4 The aircraft was not fitted with a cockpit voice recorder (CVR) nor was it a requirement to have one installed, according to the CAR 2011 Sub-part 135.05.11, read together with SA-CATS 135.05.11 (refer to Appendix A and B).

1.11.5 ICAO Annex 6, Volume 1, Chapter 6, standard 6.3.2.1.4 states the following:

All aeroplanes of maximum certified take-off mass of over 5700kg for which the individual certificate of airworthiness 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 aeroplanes, 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

1.12.1 The crew aborted take-off on 8 November 2019 on Runway 07 at FALA due to smoke and oil smell in the cockpit. The crew taxied the aircraft to the hangar. On inspection of the aircraft, it was found that the right main landing gear tyre had deflated and, shortly after, the left main landing gear tyre also deflated due to the melting of fuse plugs, which is normal when the wheel assembly was subjected to excessive heat during braking.

Figure 5: Fuse plug on aircraft tyre.

1.12.2 Fusible Plug aircraft tyres:

1.12.2.1 A fuse plug is a threaded cylinder made of brass or bronze. This type of plug is drilled right through, and the hole is filled with a metal of lower melting point. This metal will melt at a predetermined temperature, thus deflating the aircraft tyre.

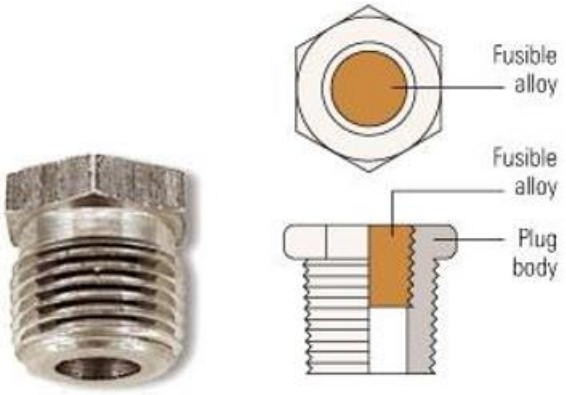


Figure 6: A fuse plug. (Source Sinomas)

1.13 Medical and Pathological Information

1.13.1 None.

1.14 Fire

1.14.1 There was no evidence of fire before or after the serious incident.

1.15 Survival Aspect

1.15.1 The serious incident was considered survivable as the aircraft did not sustain damage to the cockpit and cabin areas that would have led to the occupants sustaining serious injuries.

1.16 Tests and Research

1.16.1 JT15D-4 engine

The following information was extracted from the JT15D-1/1A/1B/4/4B/4D Pratt & Whitney Training Manual:

The JT15D is a Pratt and Whitney engine which is among the modern turbofans that uses centrifugal compressor as its main high-pressure system. In the turbo fan, most of the jet thrust is generated by the cold air blown past the engine, and the internal jet portion is quite small. In the JT15D the fan blows about 70% of the air into the bypass duct, producing most of the overall thrust. On the JT15D-4 models and above there is a small booster axial stage just behind the fan which is running at the same speed as the fan and directing the remaining 30% of the airflow into the engine core. This air is further compressed by the centrifugal stage.

1.16.2 Bearing compartment sealing

The purpose of bearing compartment sealing is to prevent oil leaking outside the bearing cavities.

1.16.3 Description

The impeller back face air is used to prevent oil from leaking into areas where it is not required or where it would be detrimental to the engine operation. A Labyrinth Air Seal consists of two separate parts, one multi-grove ring rotating with the shaft and one stationary ring with a straight surface see figure 8. A small clearance is maintained between the two parts and pressure air is allowed to leak between them to create the required sealing. Air flows into the bearing compartments and is evacuated by oil scavenge system. The breather impeller located in the Accessory Gearbox allows the air to be discharged overboard.

Figure 7: The labyrinth seal halves. (Source: Slideplayer.com)

1.16.4 Maintenance (Source: JT15D-1/1A/1B/4/4B/4D Pratt & Whitney Training Manual)

Labyrinth seals are normally maintenance free items. Premature wear would be an indication of severe unbalance or bearing distress, which would be evident to the crew. A malfunction of the oil system even though improbable, may cause flooding of certain cavities and possible smoke at the exhaust or oil smell in the cabin. No repair can be carried out at the field level, the engine must be taken back to the manufacturer.

1.16.5 General

Internal passages in the engine guide P3 air and impeller back face air pressure for cooling of various hot sections and components like the combustion chamber liner and stators. P3 air is also tapped from the gas generator for various application around the airframe such as environmental control. See figure 9.

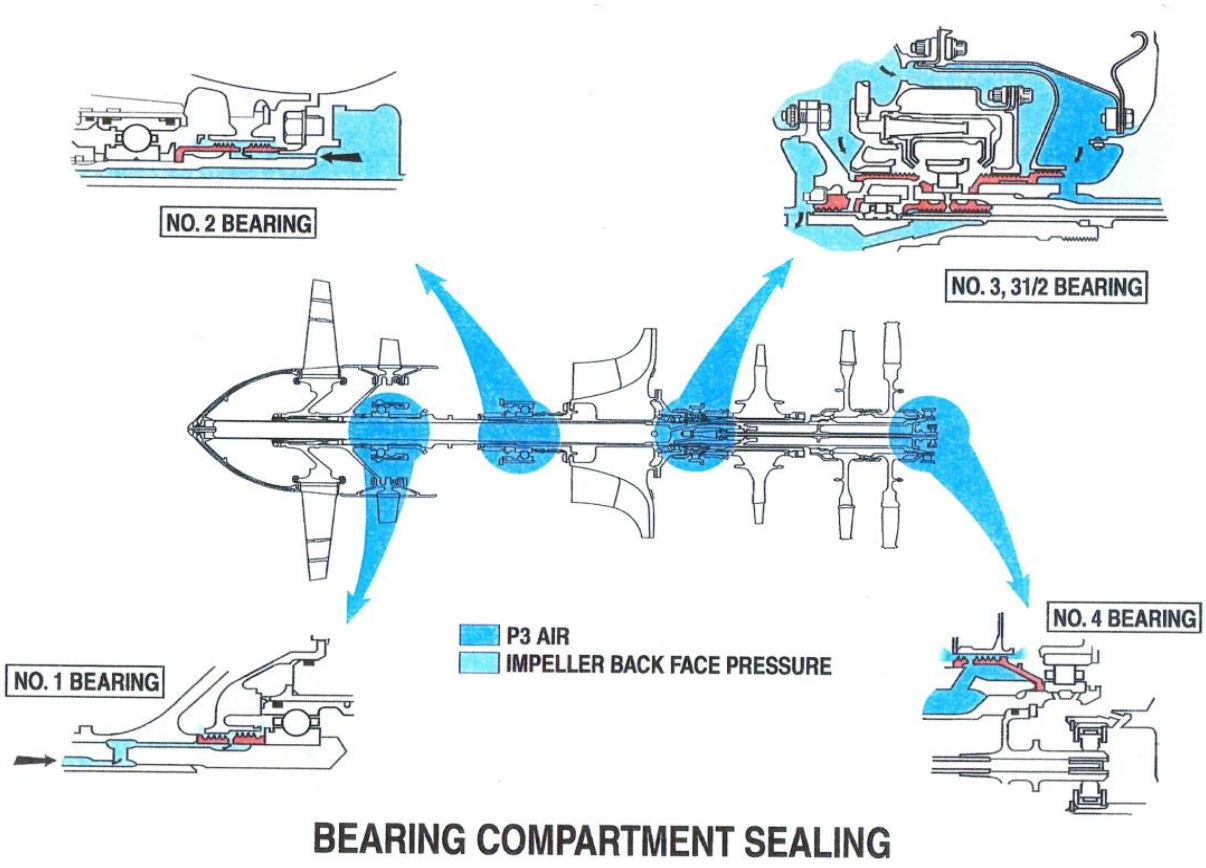


Figure 8. Bearing compartment sealing showing source of leak on bearing number 3. (Source: JT5D-1/1A/1B/4/4B/4D engine training manual)

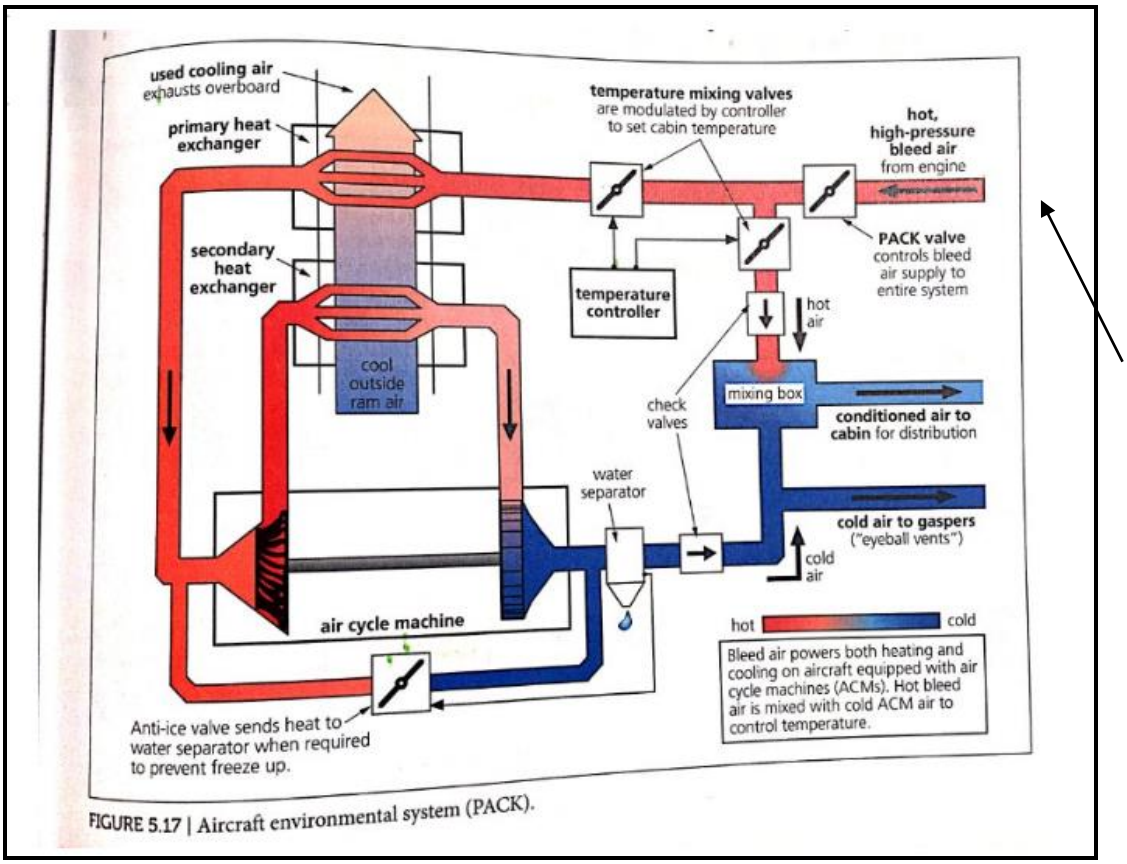


Figure 9: Arrow showing entry of P3 air of Citation 550 air conditioning system. (Source: https://i.stack.imgur.com/JhCt7.jpg)

1.16.6 The aircraft environmental system is dependent on the P3 air that is generated by the engines. The P3 air is generated by air being sucked in through the engine intake, this air then gets compressed by N2 compressor/impeller. As the air gets compressed it heats up thus allowing hot air to be tapped from the engine. If by some means of inadequate sealing of oil from Bearing number 3 there you will find the oil being vaporized in this stream of air that has been compressed and heated by the N2 compressor, and that's how you can find smoke being introduced to the environmental system and into the cabin and cockpit.

1.16.7 The operations procedure of the pressurisation/environmental system is attached to this report as Appendix D.

1.16.8 During troubleshooting of the number 1 engine oil leak and smoke in the cockpit, the AMO told the investigation team that they had followed the manufacturer's "Fault Isolation" as contained in the maintenance manual chapter 72-00-00. Figures 10, 11 and 12 are extracts from the maintenance manual chapter 72-00-00.

Table 103 Fault Isolation for Engine Lubrication Problems

FIGURE TITLE	FIGURE NO.
High Oil Temperature	118
Low Oil Pressure	119
Fluctuating Oil Pressure	120
High Oil Pressure	121
Excessive Oil Consumption	122
Oil leaks from AGB Overboard Drains	123
Oil Leak from No.4 Bearing Area or Smoke Out of Tail Pipe	124
Discolored Oil	125
Impending Oil Filter Bypass Indication	126
Oil Filter Bypass Indication	127

Figure 10: Fault isolation troubleshooting flow diagram.

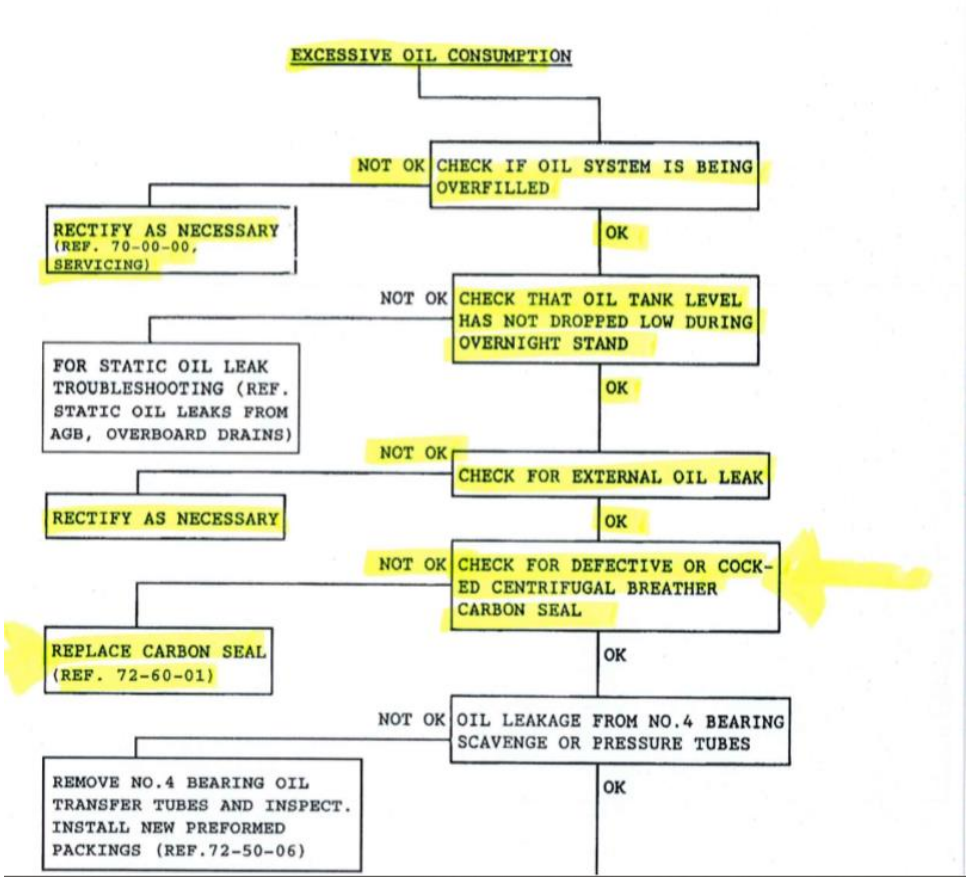


Figure 11: Excessive oil consumption troubleshooting flow diagram (a).

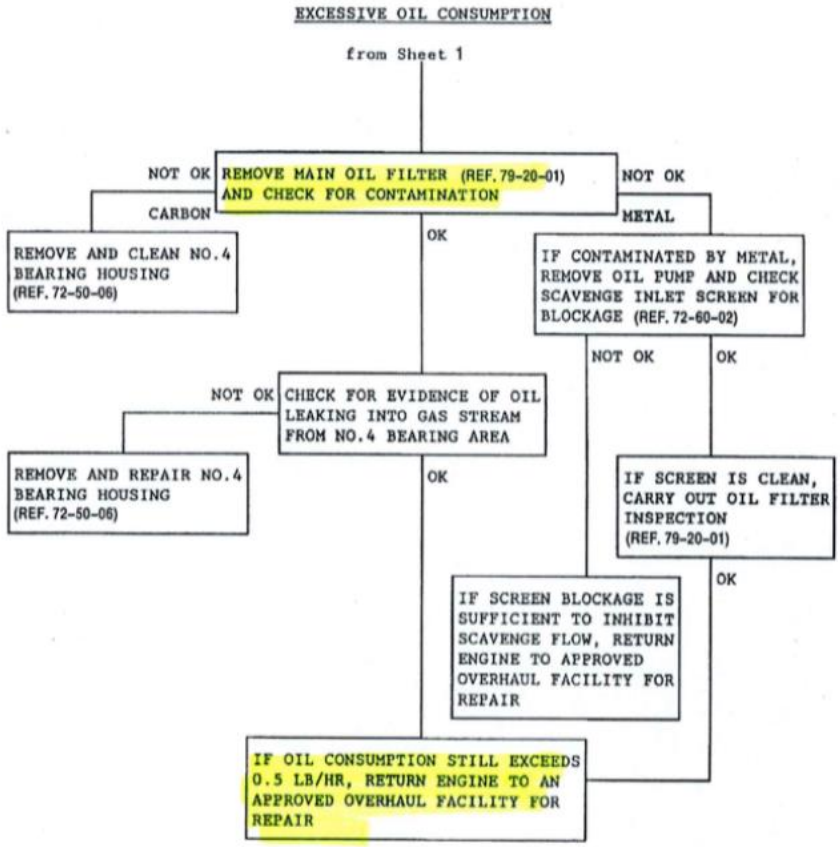


Figure 12: Excessive oil consumption troubleshooting flow diagram (b).

1.17 Organisational and Management Information

1.17.1 The flight was conducted in accordance with the provisions of Part 135 of the CAR 2011 as amended.

1.17.2 The operator FIU was in possession of a valid air operating certificate (AOC) No. CAA/G599D, which was issued on 1 March 2019 with an expiry date of 28 February 2020.

1.17.3. It was found that the operator only reported the serious incident of oil smell and smoke in the cockpit on 8 November 2019, other serious incidents were not reported to the AIID. It was the serious incident of 8 November 2019 that triggered the investigation by the AIID.

1.17.4. Following the serious incident of an abortive take-off due to the oil smell and smoke in the cockpit on 8 November 2019, the AMO and the operator elected to carry out a borescope inspection which revealed excessive oil on the face of the high-pressure compressor (HPC) and recommended that the operator and the AMO consult the manufacturer for advice on the way forward. The AMO and the operator never consulted the manufacturer, however, they consulted a manufacturer-approved maintenance facility (Dallas Air Motive) which advised them to change the scavenge pump.

1.17.5. The AMO which carried out the last maintenance inspection on this aircraft was issued an AMO approval on 31 October 2019 with an expiry date of 31 October 2020.

1.17.6. It was also found that the aircraft had defects on the flight folio which were submitted by the operator and the AMO, and which were not signed out, thus, not corrected in line with the manufacturer's instructions, in particular, flight folio numbers 68372, 68379, 68388, 68393 and 68396 as submitted by the AMO and the operator to the investigators.

1.17.7. Subsequent to FIU (operator) receiving a draft final report of ZS-CAR serious incident, FIU resubmitted flight folios as stated in paragraph 1.17.6 where defects were signed off with the exception of flight folio 68396. The following were the investigators' observations:

- All other multiple faults/defects in the operator's flight folios were signed out and stamped individually by the engineers who corrected the faults/defects. However, in the flight folios stated in paragraph 1.17.6 that were resubmitted by the operator, the multiple faults/defects were signed out (as a group) using a single signature and a single stamp by the engineer who worked on the faults/defects. The investigation found this to be inconsistent with the other flight folios that were made available to the investigators.
- The flight folio number 68396 had only one snag which had not been signed out since the crew registered it in the flight folio on 10 July 2019. As of the release of this report, the defect was still not signed out.

- The defect logged in flight folio 68393 was signed out or corrected before the defect occurred. This possibly indicate an error in date entered since it is not possible to fix the defect before it had occurred.

1.18 Additional Information

1.18.1 During the interview with the engineer, as well as the AMO representatives, it was explained to the investigators that when the engine change is performed, they do not record the oil uplift since they take it as a complete replenishment of the engine oil system. Both the AMO and the operator did not record the oil upliftment whenever oil was replenished on the engines, this was also observed on the flight folio records that oil upliftment was never recorded by the AMO nor the operator.

1.19 Useful or Effective Investigation Techniques

1.19.1 None.

2. ANALYSIS

2.1 General

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

2.2 ANALYSIS

Pilots

2.2.1 The PIC was initially issued an Airline Transport Pilot Licence (ATPL) on 20 December 2011. His last skills test was carried out on 24 January 2019 and the licence was reissued on the same day with an expiry date of 29 February 2020. He was issued a Class 1 aviation medical certificate on 23 October 2019 with an expiry date of 31 October 2020.

2.2.2 The FO was initially issued a Commercial Pilot Licence (CPL) on 16 May 2014. Her last skills test was carried out on 15 March 2019 and the licence was reissued on the same day with an expiry date of 31 March 2020. She was issued a Class 1 aviation medical certificate on 26 September 2019 with an expiry date of 30 September 2020.

Technicians

2.2.3 The aircraft maintenance engineer (AME) who performed maintenance on the ZS-CAR aircraft was issued an Aircraft Maintenance Licence on 12 November 2012. The engineer

misdiagnosed the number 1 engine oil leak and smoke in the cockpit and was unable to rectify the defect of smoke in the cockpit when it was reported by the crew on 7 November 2019. The engineer stated that he had requested that the crew leave the aircraft in the configuration in which the smoke occurred, and that was not done by the crew. However, the investigation established that the engineer never consulted the maintenance manual for guidance in rectifying the defect; the manufacturer's maintenance manual required that the engineer operate the control knob in "normal" mode to be able to simulate the defect of smoke in the cockpit. The cockpit smoke defect occurred in-flight on 7 November 2019 and the control knob is always selected on "normal" mode for the flight as required by flight operations manual. The defect reoccurred on 8 November 2019 and the crew aborted take-off and returned to base. The engineer, once again, continued to troubleshoot the cockpit smoke with the control knob on "ground" mode and there was no smoke in the cockpit because when the control knob is selected on "ground" mode, the defective engine (number 1 engine) is not supplying air into environmental and air-conditioning system, hence, the defect could not be simulated. However, when the captain joined the engineer in the cockpit and noticed that the control knob was placed on "ground" mode, he moved the control knob to "normal" mode and it was then that the smoke occurred in the cockpit. When the control knob is placed on "normal" mode, both engine number 1 and engine number 2 supply the compressed and heated air to the aircraft cabin and cockpit.

Aircraft

2.2.4 The aircraft was initially issued a Certificate of Airworthiness (C of A) on 28 October 1986; and the C of A was reissued in October 2019 with an expiry date of 30 October 2020. The aircraft was also issued a certificate of registration on 26 August 2010.

2.2.5 On 27 May 2019, the engine number 1 with part number JT15D-4B and serial number 102175 with 9811.7 hours was removed and replaced with another engine with part number JT15D-4B and serial number PCE-70925 with 8094.6 hours and had accumulated 171.3 hours since installation.

2.2.6 The operator and the AMO had no records of engine oil consumption monitoring and all oil upliftment done by the AMO and the operator were not recorded in the aircraft flight folio; this was in contravention of the Civil Aviation Regulations Part 91.03.6(2),(3) and Part 91.03.5 read together with SA-CATS 91.03.5 and manufacturer's maintenance manual 72-00-00 Rev 44 29/04/2019 (Engine Turbine Inspection) which require that if oil contents is below the required level on the dipstick, the operator/AMO needs to consult the AMM Chapter 72-00-00 Fault Isolation and Engine Lubrication to further troubleshoot the problem.

2.2.7 On 7 November 2019, the flying crew reported an oil smell and smoke in the cockpit whilst on approach for landing at FAWB. They opted to carry out a missed approach before diverting to FALA, which is their maintenance home base. After landing at FALA, an inspection of both engines was carried out. Engine number 1 was found with no visible oil after checking its dipstick. The technical crew then topped up engine number 1 with three cans of oil. Engine number 2 was also topped up with one can of oil. This was a clear indication of excessive oil consumption in engine number 1, however, since the AMO and the operator were not recording and monitoring oil consumption, the engine was returned to service. According to the manufacturer's maintenance manual (Chapter 72-00-00 Fault Isolation, Engine Lubrication Problem) if it is determined that the engine oil consumption is more than 0.5 lb (0.227 litres) per hour, the engine needs to be removed from the aircraft and sent to the repair shop for overhaul and/or repairs. The engine oil consumption was excessive as three cans of oil had to be uplifted on 7 November 2019, however, the engine was allowed to continue in service. This was in contravention of Part 43.02.3 of the Civil Aviation Regulations (CAR) 2011 as amended.

2.2.8 The aircraft was fitted with a flight data recorder (FDR). The FDR was not downloaded since the data was overwritten and it was deemed not necessary for this investigation. However, the operator had an obligation of conducting FDR test and downloads annually to ensure that the recorded data from FDR operates correctly for the nominal duration of the recording. The operator did not conduct the annual test and download of the FDR when it was due on January 2019 and that was in contravention of Part 135.05.10 read together with SA-CATS 135.05.10(2)(4) to (9). It was determined that the test and download of the FDR on 8 January 2018 did not cover all mandatory parameters as required by Part 135 of the CAR 2011 as amended.

2.2.9 The maintenance manual pre- and post-flight inspections requirements of the aircraft were carried out by the AMO when the aircraft was operating from base in Lanseria, however, when the aircraft was on a mission away from maintenance home base (Lanseria Airport), the pre- and post-flight inspection were carried out by the pilot. The operator did not have maintenance arrangement for maintenance support in instances where the aircraft was operating away from maintenance home base, therefore, maintenance required by manufacturer's maintenance manual including maintenance requirements from Maintenance Manual Chapter 72-00-00 Rev 44 29/04/2019 (Engine Turbine Inspection) were not being carried out by the AMO. This was in contravention of the Civil Aviation Regulations Part 43.02.2.

2.2.10 The review of the operator's flight folio revealed that there were defects raised by the crew in the flight folio (log numbers: 68372, 68379, 68388, 68393 and 68396) and such defects were never corrected according to the flight folio records. The operator was in contravention of the Civil Aviation Regulations Part 43.02.4(3) read together with Part 43.04.11.

2.2.11 Subsequent to FIU (operator) receiving a draft final report of ZS-CAR serious incident, FIU resubmitted flight folios as stated in paragraph 1.17.6 where defects were signed out with the exception of flight folio 68396. The following were the investigators' observations:

- All other multiple faults/defects in the operator's flight folios were signed out and stamped individually by the engineers who corrected the faults/defects. However, in the flight folios stated in paragraph 1.17.6 that were resubmitted by the operator, the multiple faults/defects were signed out (as a group) using a single signature and a single stamp by the engineer who worked on the faults/defects. The investigation found this to be inconsistent with the other flight folios that we made available to the investigators.
- The flight folio number 68396 had only one snag which had not been signed out since the crew registered it in the flight folio on 10 July 2019. As of the release of this report, the defect was still not signed out.
- The defect logged in flight folio 68393 was signed out or corrected before the defect occurred. This possibly indicate an error in date entered since it is not possible to fix the defect before it had occurred.

2.2.12 On 8 November 2019, the aircraft, with four persons on-board, was scheduled to depart Lanseria International Airport (FALA) to Polokwane International Airport (FAPP) in which the crew was scheduled to carry out ground navigation systems calibration. The start-up and taxi were uneventful. During the take-off roll, the crew experienced an oil smell and smoke in the cockpit again. The crew decided to abort take-off, and the aircraft was taxied back to the hangar before the engines were shut down. This was an indication that the defect of oil smell and smoke in the cockpit that was reported by the crew on 7 November 2019 was never corrected. This was the first flight following the defect of 7 November 2019. The investigation determined that the AMO conducted compressor wash and, following the compressor wash, the aircraft was returned to service the next day on 8 November 2019. Therefore, the AMO did not properly diagnosed the defect of 7 November 2019 and as a result, the defect recurred on 8 November 2019.

2.2.13 Before the engine was removed from the aircraft, a new oil scavenging pump was fitted on 25 November 2019; the aircraft was ground run to confirm correct operation of the engine. A test flight was requested, two borescope inspections were carried out on engine number 1 on 8 November and 29 November 2019, respectively. Both borescope inspections revealed evidence and a presence of oil in the HPC. The AMO and the operator

were advised to contact the manufacturer on both occasions. The investigators could not find evidence of either the AMO or the operator contacting the manufacturer for assistance as recommended by the borescope inspection results, however, there was evidence that both the AMO and the operator had contacted the manufacturer-approved service facility (Dallas Air Mortive) instead of the manufacturer. Following the second borescope inspection, it was determined that the number 1 engine oil leak and the presence of oil in the HPC was caused by the worn labyrinth seal from the number 3 bearing. The results of the second borescope led the AMO to the conclusion that the number 3 bearing seal was worn. As a result of the presence of oil in the HPC, whenever the aircraft environmental system was selected on "normal" mode (meaning compressed and heated air is supplied from both engine number 1 and engine number 2 HPC) the oil in the HPC area mixed with the compressed and heated air, resulting in the oil smell and smoke in the cockpit.

2.2.14 The investigation revealed that during the take-off roll, the crew experienced an oil smell and smoke in the cockpit as a result of the number 3 bearing labyrinth seal failure of number 1 engine. This caused the oil to leak into the HPC and the oil mixed with compressed and heated air, resulting in the oil smell and smoke in the cockpit.

3 CONCLUSION

3.1 General

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

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

- **Findings —** are statements of all significant conditions, events or circumstances in this serious incident. The findings are significant steps in this serious incident sequence, but they are not always causal or indicate deficiencies.
- **Causes —** are actions, omissions, events, conditions, or a combination thereof, which led to this serious incident.
- **Contributing factors —** are actions, omissions, events, conditions, or a combination thereof, which, if eliminated, avoided or absent, would have reduced the probability of the accident or serious incident occurring, or mitigated the severity of the consequences of the serious incident. The identification of contributing factors does not imply the assignment of fault or the determination of administrative, civil or criminal liability.

3.2 Findings

Pilots

3.2.1 The PIC was reissued an Airline Transport Pilot Licence (ATPL) on 24 January 2019 with an expiry date of 29 February 2020; the aircraft type was endorsed on his licence. He was also issued a Class 1 aviation medical certificate on 23 October 2019 with an expiry date of 31 October 2020.

3.2.2 The FO was issued a Commercial Pilot Licence (CPL) on 15 March 2019 with an expiry date of 31 March 2020; the aircraft type was endorsed on her licence. She was also issued a Class 1 aviation medical certificate on 26 September 2019 with an expiry date of 30 September 2020.

Technicians

3.2.3 The aircraft maintenance engineer (AME) was in possession of an Aircraft Maintenance Licence which was initially issued on 12 November 2012. The engineer was adequately qualified as an AME who is rated on the aircraft type.

Aircraft

3.2.4 The aircraft was issued a Certificate of Airworthiness (C of A) on 28 October 1986 with an expiry date of 30 October 2020.

3.2.5 The aircraft was also issued a Certificate of Registration (C of R) on 2 August 2019.

3.2.6 The last maintenance inspection of the aircraft was carried out on 2 August 2019 at 10031.1 airframe hours. After the inspection, the aircraft operated for a further 59.6 hours.

3.2.7 On 27 May 2019, the engine number 1 with part number JT15D-4B and serial number 102175 with 9811.7 hours was removed and replaced with another engine with part number JT15D-4B and serial number PCE-70925 with 8094.6 hours. The removed engine had accumulated 171.3 hours since installation on ZS-CAR.

3.2.8 On 25 November 2019, a new oil scavenging pump was fitted to the left-hand engine. The AMO carried out a ground run to confirm correct operation of the engine. A test flight was requested.

It was found that the operator (through ATC) only reported the serious incident of an oil smell and smoke in the cockpit on 8 November 2019; other serious incidents (7, 26 and 29 November 2019) were not reported to the AIID. It was the serious incident of 8 November

2019 that triggered the investigation by the AIID. This was in contravention of Part 12.02.2 of the CAR 2011 as amended.

3.2.9 Following the serious incident of a reported oil smell and smoke in the cockpit, an inspection of both engines was carried out, and engine number 1 was found with no visible oil after checking its dipstick. The technical crew then topped up engine number 1 with three cans of oil and engine number 2 was also topped up with one can of oil. This was a clear indication that the number 1 engine was consuming more oil, but due to both the operator and the AMO not monitoring the oil uplifts of both engines, they missed that the number 1 engine was consuming excessive oil and that it needed to be removed.

3.2.10 It was found that the operator and the AMO did not follow the recommendation of the borescope inspection as they should have contacted the manufacturer. They would have been advised to remove the engine as stipulated in the manufacturer's training manual which states, "…*A malfunction of the oil system even though improbable, may cause flooding of certain cavities and possible smoke at the exhaust or oil smell in the cabin. No repair can be carried out at the field level, the engine must be taken back to the manufacturer."*

3.2.11 It was also found that the AME misdiagnosed the reported serious incident of an oil smell and smoke in the cockpit/cabin as a result of a reliance on what the crew was informing him and also that he was not following the manufacturer's prescribed maintenance practises by continually attempting to simulate the serious incident whilst the environmental/ pressurisation system control knob was on "ground" mode rather than being on "normal" mode.

3.2.12 The aircraft was not fitted with a CVR and it was not a requirement to be fitted on this aircraft according to CAR 2011 Subpart 135.05.11. The ICAO Annex 6, Volume 1, Chapter 6, Recommendation 6.3.2.1.5 state the following:

> *All turbine-engine aeroplanes, 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.*

3.2.13 The aircraft was fitted with a FDR, however, it was not downloaded for this investigation. The download was already overwritten, and the FDR download was concluded as not necessary for this occurrence. The FDR was tested and downloaded for serviceability on 8 January 2018, however, it was not tested nor downloaded on its next due date in January 2019. It was also found that the required parameters for a download were not all done during the testing and download carried out on 8 January 2018.

3.2.14. The review of the operator's flight folio revealed that there were defects raised by the crew in the flight folio (log no: 68372, 68379, 68388, 68393 and 68396) and these defects were never corrected according to the flight folio records. The operator was in contravention of the Civil Aviation Regulations Part 43.02.4(3) read together with Part 43.04.11.

3.2.15 Subsequent to FIU (operator) receiving a draft final report of ZS-CAR serious incident, FIU resubmitted flight folios as stated in paragraph 1.17.6 where defects were signed out with the exception of flight folio 68396. The following were the investigators' observations:

- All other multiple faults/defects in the operator's flight folios were signed out and stamped individually by the engineers who corrected the faults/defects. However, in the flight folios stated in paragraph 1.17.6 that were resubmitted by the operator, the multiple faults/defects were signed out (as a group) using a single signature and a single stamp by the engineer who worked on the faults/defects. The investigation found this to be inconsistent with the other flight folios that we made available to the investigators.
- The flight folio number 68396 had only one snag which had not been signed out since the crew registered it in the flight folio on 10 July 2019. As of the release of this report, the defect was still not signed out.
- The defect logged in flight folio 68393 was signed out or corrected before the defect occurred. This possibly indicate an error in date entered since it is not possible to fix the defect before it had occurred.

3.2.16 The investigation revealed that during the take-off roll, the crew experienced an oil smell and smoke in the cockpit as a result of the number 3 bearing labyrinth seal failure of engine number 1. This caused the oil to leak into the high-pressure compressor and the oil mixed with compressed and heated air, resulting in the oil smell and smoke in the cockpit.

3.2.16.1 Contributory factors:

- The AMO and the operator were not monitoring the oil consumption of the number 1 engine
- The AMO/AME misdiagnosed the defect as a result of not complying with the manufacturer's recommended practise
- The operator and the AMO's non-compliance of safe and standard recommended practises issued by the manufacturer and the Civil Aviation Regulations

3.3 Probable Cause/s

3.3.1 During the take-off roll from Lanseria International Airport, the crew experienced an oil smell and smoke in the cockpit as a result of the number 3 bearing labyrinth seal failure of engine number 1. This caused the oil to leak into the high-pressure compressor and the oil

mixed with compressed and heated air, resulting in the oil smell and smoke in the cockpit.

3.3.2 Contributory factors:

3.3.2.1.1 The AMO and the operator were not monitoring the oil consumption of the number 1 engine.

3.3.2.1.2 The AMO/AME misdiagnosed the defect as a result of not complying with the manufacturer's recommended practise.

3.3.2.1.3 The operator and the AMO's non-compliance of safe and standard recommended practises by the manufacturer and the Civil Aviation Regulations.

4 SAFETY RECOMMENDATIONS

4.1 General

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

4.2 Recommendation/s

4.2.1 It is recommended to the Director of Civil Aviation that in the conduct of safety oversight, the SACAA ensures that operators and aircraft maintenance organisations comply with the manufacturer's maintenance instructions for safe operation of the aircraft. The operator and the AMO were not recording and monitoring the oil consumption of the engines.

4.2.2 It is also recommended that the operator and the aircraft maintenance organisation ensure that they adhere to the Civil Aviation Regulations requirements and the manufacturer's maintenance requirements.

5 APPENDICES

5.1 Appendix A: Oil sample reports

5.2 Appendix B: CVR requirements according to CAR 2011 Part 135.

5.3 Appendix C: CVR requirements according to SA-CATS Part 135.

5.4 Appendix D: Pressurisation/Environmental system operation

5.5 Appendix E: Aircraft checklist for smoke in the cockpit

5.6 Appendix G: Universal Readout Support Equipment Transcript Results

5.7 Appendix G: FIU Comments in Response to the Draft Final Report with Responses From AIID

This Report is issued by:

Accident and Incident Investigations Division
South African Civil Aviation Authority
Republic of South Africa

Appendix A

WEAR CHECK
Condition Monitoring Specialists

AIRCRAFT

PROBLEM SEVERITY

NORMAL

KWAZULU-NATAL:
P.O. BOX 15108
WESTMEAD 3608
TEL: (031) 700 5460
FAX: (031) 700 5471

GAUTENG:
P.O. BOX 284
BANDO 1600
TEL: (011) 392 6332
FAX: (011) 392 6340

Mr C Louw [Chric]

Exeoujet Maintenanoe (Pty) Ltd
P O Box 2
Lanceria
1748

Registration	: ZS-CAR	Code	: 8EMALA
Aircraft type	: CESSNA S550	Job No.	:
Component	: LEFT ENGINE	Location	: DEP OF TPT
Model	: PRATT & WHITNEY JT15D-4B	Oil	: EASTMAN TURBO OIL 2380
Serial no.	: PCE70925	Queries	: PLEASE CONTACT DIAGNOSTIC DEPARTMENT.

Maintenanoe :

OIL FILTER/FERROGRAPH DIAGNOSIS	
1.) SAMPLE NO. FG223085 on 19.11.2019 comp. time 8205 Metal found in transfer tube screen. The oil analysis is normal. The filter debris analysis indicates the engine is operating normally. Continue sending samples at the recommended interval.	

PREVIOUS HISTORY

DIAGNOSES	ACTION TAKEN

P.T.O.

Registration: ZS-CAR - LEFT ENGINE - Serial no.: PCE70925

	SAMPLE NUMBER	DATE SAMPLED	LAB DATE	COMPONENT TIME	PERIOD FILTER IN USE	TIME SINCE OVERHAUL
1	FG223085	19.11.19	21.11.19	8265		

STEEL ALLOY WEAR PARTICLES

Sample	Plain Carbon Steel	alloy steel 4340	alloy steel 9310	tool steel M50	stainless steel 400 series	stainless steel 300 series	ppt hardened steel 17-4
1	1	0	0	0	0	0	0

OTHER WEAR PARTICLES

Silver	Aluminium	Magnesium	Copper	Lead
0	1	0	0	0

CONTAMINANTS

Carbon	grit	fibre	sealant / grease	Other
2	1	0	1	1

Major = 3 Minor = 2 Trace = 1 Not detected = 0

TOTAL FILTER DEBRIS ANALYSIS

Too few values to plot mass (mg) filter patch

Too few values to plot pqi filter patch

Sample	mass (mg) filter patch	pqi filter patch	pqi oil
1	37	2616	32

MICROSCOPIC PARTICLE EXAMINATION

Sample	rubbing	cutting	sliding	spherical	chunky	oxide	non ferrous	polymeric
1	1	0	0	0	0	0	1	0

0 = none 1 = very few 2 = few 3 = some 4 = moderate 5 = heavy

GRAPHICAL REPRESENTATION OF PARTICLE SHAPE AND CONCENTRATION

Too few values to plot cutting

Too few values to plot sliding

Too few values to plot spherical

Too few values to plot chunky

Requested by dean

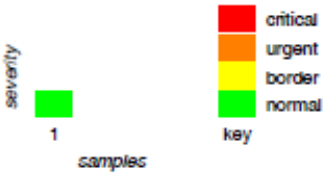
AIRCRAFT

PROBLEM SEVERITY

NORMAL

KWAZULU-NATAL:
P.O. BOX 15106
WESTMEAD 3608
TEL: (031) 700 5460
FAX: (031) 700 5471

GAUTENG:
P.O. BOX 284
ISANDO 1600
TEL: (011) 392 6322
FAX: (011) 392 6340



Mr C Louw [Chris]
Execujet Maintenance (Pty) Ltd
P O Box 2
Lanseria
1748

Registration	: ZS-CAR	Code	: 8EMALA
Serial no.	: - PCE70025	Job No.	: -
Aircraft type	: CESSNA S550	Location	: DEP OF TPT
Component	: LEFT ENGINE	Oil	: EASTMAN TURBO OIL 2380
Model	: PRATT & WHITNEY JT15D-4B	Queries	: PLEASE CONTACT DIAGNOSTIC DEPARTMENT.

DIAGNOSIS

1.) Sample Number G223085 on 19.11.2019 smr 8265 HRS
Refer to attached ferrography report.

PREVIOUS HISTORY

DIAGNOSES	FEEDBACK

P.T.O.

Registration: ZS-CAR - LEFT ENGINE - Serial no.: - PCE70925

	SAMPLE NUMBER	DATE SAMPLED	LAB DATE	OIL CONSUMPTION	SMR	UNITS	OIL IN SERVICE	FILTER CHANGE	OIL DRAIN	RRI
1	G223085	19.11.19	20.11.19	1.00	8265	HRS	-	Yes	Yes	250

WEAR METALS

Sample	Iron	Chromium	Nickel	Aluminium	Copper	Tin	Silver	Lead	Titanium	Beryllium	PQ Index
1	4.0	0.4	0.1	0.0	0.0	0.0	0.03	0.0	0.0	0	32

PARTICLE QUANTIFIER INDEX

Too few values to plot PQ Index

30 spectrometric analyses are carried out on all samples but only relevant results are reported in parts per million.

CONTAMINANTS

Sample	Silicon	Water (%)	TAN
1	0.4	ND	0.40

PARTICLE COUNT /ML

4 micron	6 micron	14 micron	20 micron	25 micron	50 micron	75 micron	100 micron	Cleanliness
30270	13885	787	173	123	2	0	0	23/21/17

30 spectrometric analyses are carried out on all samples but only relevant results are reported in parts per million.

ADDITIVES & LUBRICANT CONDITION

Sample	Magnesium	Molybdenum	Zinc
1	0.2	0.0	0.1

VISCOSITY

Too few values to plot Viscosity in cSt @ 40 C

Viscosity in cSt @ 40 C	Viscosity in cSt @ 100 C	Viscosity Index
24.6	5.2	148

30 spectrometric analyses are carried out on all samples but only relevant results are reported in parts per million.

GRAPHICAL REPRESENTATION OF KEY DATA

Too few values to plot Oil in Service

Too few values to plot Iron

Requested by dsan

Appendix B

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 aeroplanes 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 aeroplane, 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 aeroplane, 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 aeroplane moving under its own power and continue to record, until the termination of the flight when the aeroplane 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 a FDR referred to in regulation 135.05.11.

1.11.4 According to SACATs 135.05.11 (COCKPIT VOICE RECORDERS) (Refer to table below) the aircraft did not require to be equipped with a CVR because the aircraft was registered in 1986, is turbine powered but weighs less then 27000kg therefore all the items below would not be applicable.

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

engine ITT and fan speed when the ignitors are turned ON. An increase in both fan speed and ITT indicates proper step modulator operation. The engine anti-ice must be off for this check to isolate the affect of the bleed air loss from the increased fuel schedule.

LOW FUEL LEVEL WARNING SYSTEM

The low fuel level warning system provides a visual warning to the pilot when a minimum of 185 pounds of usable fuel remains in either fuel tank. The system consists of an electromagnetic float switch in each fuel tank and left and right FUEL LOW LEVEL lights. These lights are tested by the annunciator panel, test switch and dimmed by the same control as the annunciator panel. A minimum usable fuel quantity of 185 pounds will cause an amber FUEL LOW LEVEL light to illuminate, indicating left or right tank low fuel level.

PRESSURIZATION/ENVIRONMENTAL SYSTEM

Normal system pressure is supplied by compressor bleed air from each engine at the rate of 6 pounds/minute passing through a series of control valves or precoolers and into the air cycle machine air conditioning and pressurization systems.

The control valves are combination flow control, shutoff and check valves. Valve position is controlled by a pressurization source selector switch providing OFF, GND, LH, NORM, RH and EMER positions. Normal inflight operation would be in the NORMAL mode. An electrical system malfunction will usually not affect normal pressurization. The control valves require electrical power to move from the normal mode position. If a different mode has been selected at the time electrical power to the valves is interrupted, the valves will return to the normal mode position. An overheat failure of the air cycle machine will result in automatic transfer from NORMAL mode to EMER mode. EMER mode should be used any time normal pressurization bleed air is not available. Its operation is indicated by an annunciator panel light. An increase in cabin noise level and temperature will also result since emergency bleed air comes directly from the left engine into the cabin.

The GND mode is provided to supply approximately three times the normal bleed flow (18 pounds/minute) from the right engine only for improved heating and cooling capability during ground operations. Operation in the GND mode is indicated by an annunciator panel light. The pressurization system should be operated in NORM during routine operation because in that position air is bled from both engines equally, which results in a total airflow of approximately 12 pounds/minute. LH and RH positions are provided in case bleed air must be shut off from one engine. If an air cycle machine overpressure occurs while in GND mode, due to either a malfunction or to advancing the right throttle too far, the NORM PRESS circuit breaker must be disengaged and re-engaged before air cycle machine operation can be restored. An air cycle machine overpressure is indicated by illumination

of the ACM O'PRESS light on the annunciator panel. Illumination of the ACM O'PRESS light refers to GND mode only and will not affect operation of the environmental system in NORM, LH, or RH if those selections are subsequently made, even though the ACM O'PRESS light will remain on if the NORM PRESS circuit breaker is not cycled.

Normal bleed air supply to the cabin passes through the air cycle machine which provides cooling or heating of the cabin as desired by the pilot. Normal control of cabin temperature is maintained by the AUTOMATIC TEMPERATURE CONTROL. The temperature range of this control is 18°C to 29°C. In the event that automatic control is lost, a manual control is provided. The manual control drives the bleed air mixing valves from one temperature extreme to the other, when actuated, in approximately 10 seconds.

An air cycle machine malfunction will normally result in automatically changing the bleed air supply to the emergency mode. Additional heating of the cockpit area may be obtained by turning on the COCKPIT/DEFOG fan and opening the pilot's and copilot's foot warmer vents. These vents must be closed, however, for windshield defog.

Cabin pressure is maintained at any value selected by the pilot during flight up to a maximum value of 8.8 PSI. Rate of change of cabin altitude may also be controlled by the pilot.

A guarded emergency dump switch provides a rapid dump capability for the pilot, which equalizes cabin pressure; i.e., cabin altitude becomes equal to airplane altitude regardless of airplane altitude. Pressurization source selector must be OFF to obtain complete depressurization at altitudes above 28,000 feet.

To obtain adequate cabin ventilation either on the ground or in flight with the pressurization source selector OFF, the overhead fan must be ON and the cabin should be depressurized using the emergency dump switch.

WINDSHIELD DEFOG

Windshield defog is accomplished by diverting conditioned cockpit air to the windshield and crew side windows. The overhead and defog fans must be turned to HI and the pilot's footwarmers CLOSED to obtain defogging. The defog fan should be turned on 15 minutes or more prior to descent from altitude to provide adequate clearing for descent into high humidity conditions. If the descent is begun prior to turning on the defog, the windshield anti-ice should be turned on to assure defogging.

If the outside of the windshield fogs over after landing, the windshield bleed air should be turned to LOW to clear the windshield.

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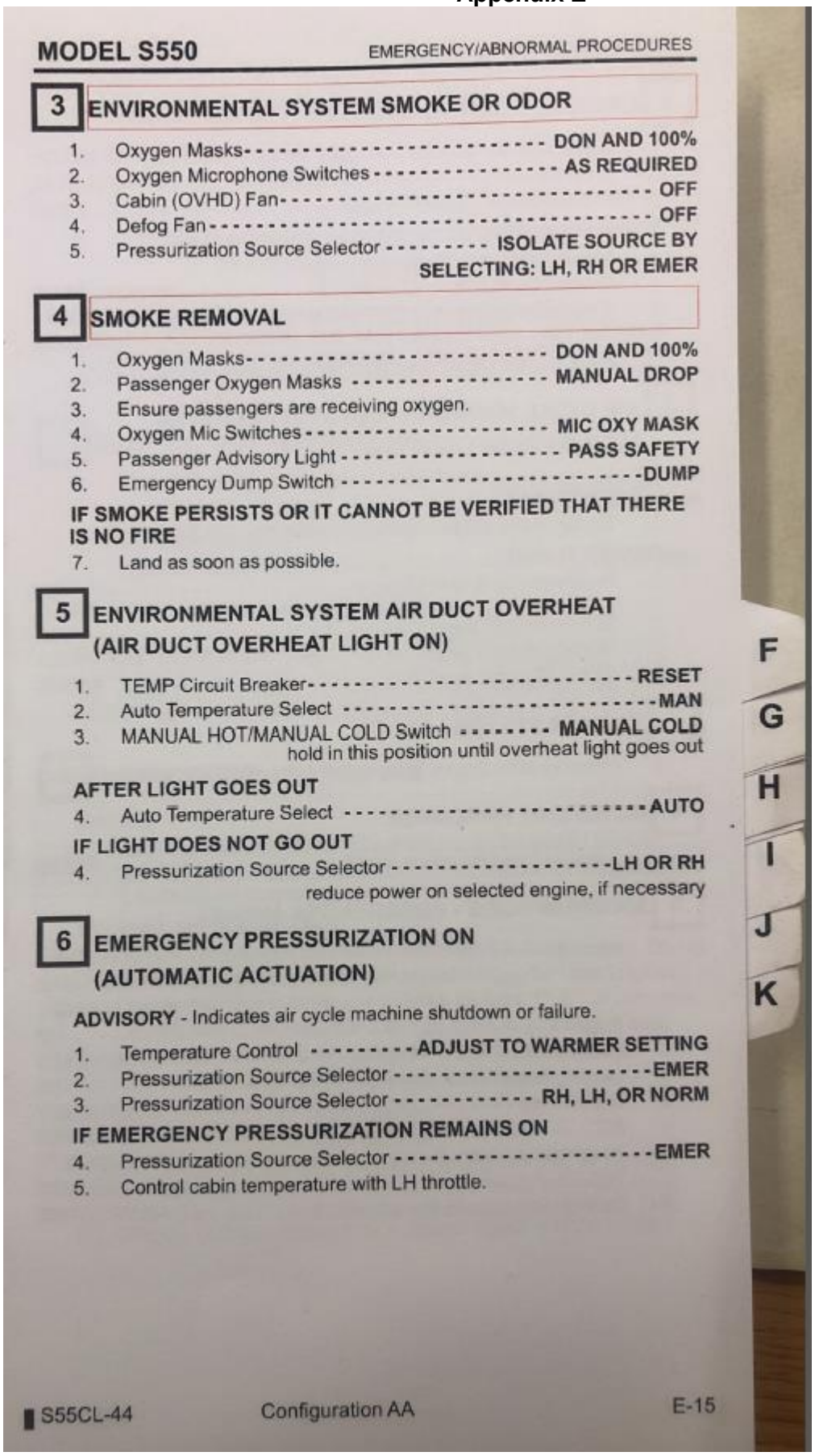
Revision 10



3 ENVIRONMENTAL SYSTEM SMOKE OR ODOR

1. Oxygen Masks - DON AND 100%
2. Oxygen Microphone Switches - - - - - - - - - - - - - - - - AS REQUIRED
3. Cabin (OVHD) Fan - OFF
4. Defog Fan - OFF
5. Pressurization Source Selector - - - - - - - - - ISOLATE SOURCE BY SELECTING: LH, RH OR EMER

4 SMOKE REMOVAL

1. Oxygen Masks - DON AND 100%
2. Passenger Oxygen Masks - - - - - - - - - - - - - - - - - - MANUAL DROP
3. Ensure passengers are receiving oxygen.
4. Oxygen Mic Switches - MIC OXY MASK
5. Passenger Advisory Light - - - - - - - - - - - - - - - - - - PASS SAFETY
6. Emergency Dump Switch - DUMP

IF SMOKE PERSISTS OR IT CANNOT BE VERIFIED THAT THERE IS NO FIRE

7. Land as soon as possible.

5 ENVIRONMENTAL SYSTEM AIR DUCT OVERHEAT (AIR DUCT OVERHEAT LIGHT ON)

1. TEMP Circuit Breaker - RESET
2. Auto Temperature Select - MAN
3. MANUAL HOT/MANUAL COLD Switch - - - - - - - - MANUAL COLD
   hold in this position until overheat light goes out

AFTER LIGHT GOES OUT

4. Auto Temperature Select - AUTO

IF LIGHT DOES NOT GO OUT

4. Pressurization Source Selector - LH OR RH
   reduce power on selected engine, if necessary

6 EMERGENCY PRESSURIZATION ON (AUTOMATIC ACTUATION)

ADVISORY - Indicates air cycle machine shutdown or failure.

1. Temperature Control - - - - - - - - - ADJUST TO WARMER SETTING
2. Pressurization Source Selector - EMER
3. Pressurization Source Selector - - - - - - - - - - - - - RH, LH, OR NORM

IF EMERGENCY PRESSURIZATION REMAINS ON

4. Pressurization Source Selector - EMER
5. Control cabin temperature with LH throttle.

Appendix F

FDR parameters

(4) The parameters that satisfy the requirements for FDRs are listed in the paragraphs below.

The number of parameters to be recorded shall depend on aeroplane complexity. The parameters without an asterisk (*) are mandatory parameters which shall be recorded regardless of aeroplane complexity. In addition, the parameters designated by an asterisk (*) shall be recorded if an information data source for the parameter is used by aeroplane systems or the flight crew to operate the aeroplane. However, other parameters may be substituted with due regard to the aeroplane type and the characteristics of the recording equipment.

(5) The following parameters satisfy the requirements for flight path and speed –

(a) pressure altitude;

(b) indicated airspeed or calibrated airspeed;

(c) air-ground status and each landing gear air-ground sensor when practicable;

(d) total or outside air temperature;

(e) heading (primary flight crew reference);

(f) normal acceleration;

(g) lateral acceleration;

(h) longitudinal acceleration (body axis);

(i) time or relative time count;

(j) navigation data* (drift angle, wind speed, wind direction, latitude/longitude, groundspeed*); and

(6) The following parameters satisfy the requirements for attitude –

(a) pitch attitude;

(b) roll attitude;

(7) The following parameters satisfy the requirements for engine power –

(a) engine thrust/power (propulsive thrust/power on each engine, cockpit thrust/power lever position);

(8) The following parameters satisfy the requirements for configuration –

(a) pitch trim surface position;

(9) The following parameters satisfy the requirements for operation –

(a) warnings;

(b) primary flight control surface and primary flight control pilot input (pitch axis, roll axis, yaw axis);

AMO 080

INTERJET

UNIVERSAL READOUT SUPPORT EQUIPMENT

TRANSCRIPTION RESULTS

Page 2 of 2

ZS-CAR **P/N S703-1000-00** **S/N 00933**

TRANSCRIPTION DATE 08/01/2018 **REPORT DATE** 08 January 2018

PARAMETERS CHECKED

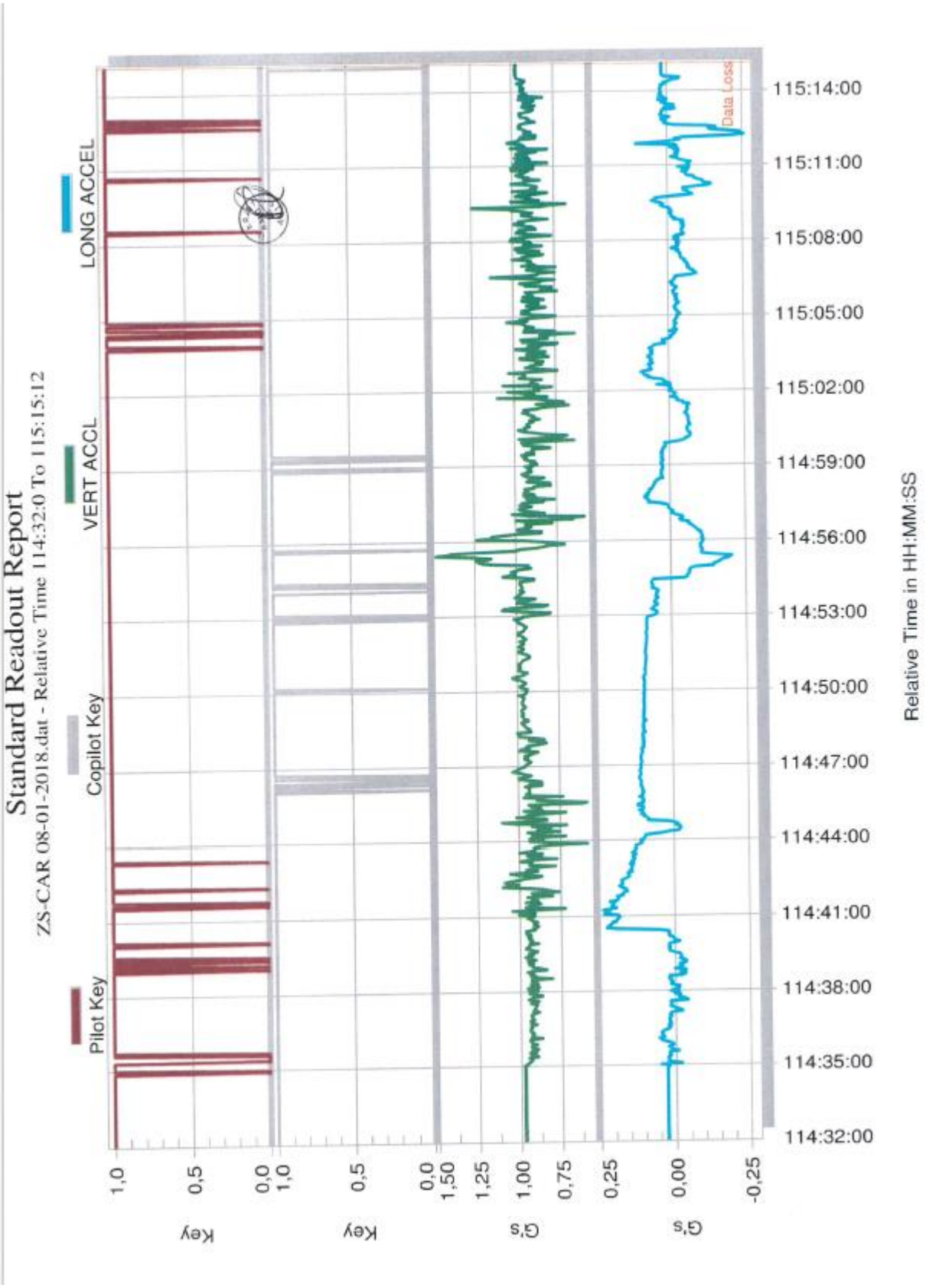
Parameter name	Parameter Description
TIME	Elapsed Time
ALT	Pressure Altitude
IAS	Indicated Airspeed
HEAD	Magnetic Heading
PITCH	Pitch Attitude
ROLL	Roll Attitude
Pilot Key	Pilot Radio transmitting
Copilot Key	Co-pilot Radio transmitting
Vert Accel	Vertical Acceleration
LONG ACCEL	Longitudinal Acceleration

Failed Parameter Description and Comments.

None

Notes: It remains the responsibility of the owner / operator to check and confirm parameter applicability of this report.

The above DFDR parameters were checked and found to be functionally correct unless otherwise stated. Please see 'SACAA 121.05.17 Flight Data Recorder' for Parameter applicability.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VERT ACCL
Copilot Key
Pilot Key
Data Loss
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115:11:00
115:08:00
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114:56:00
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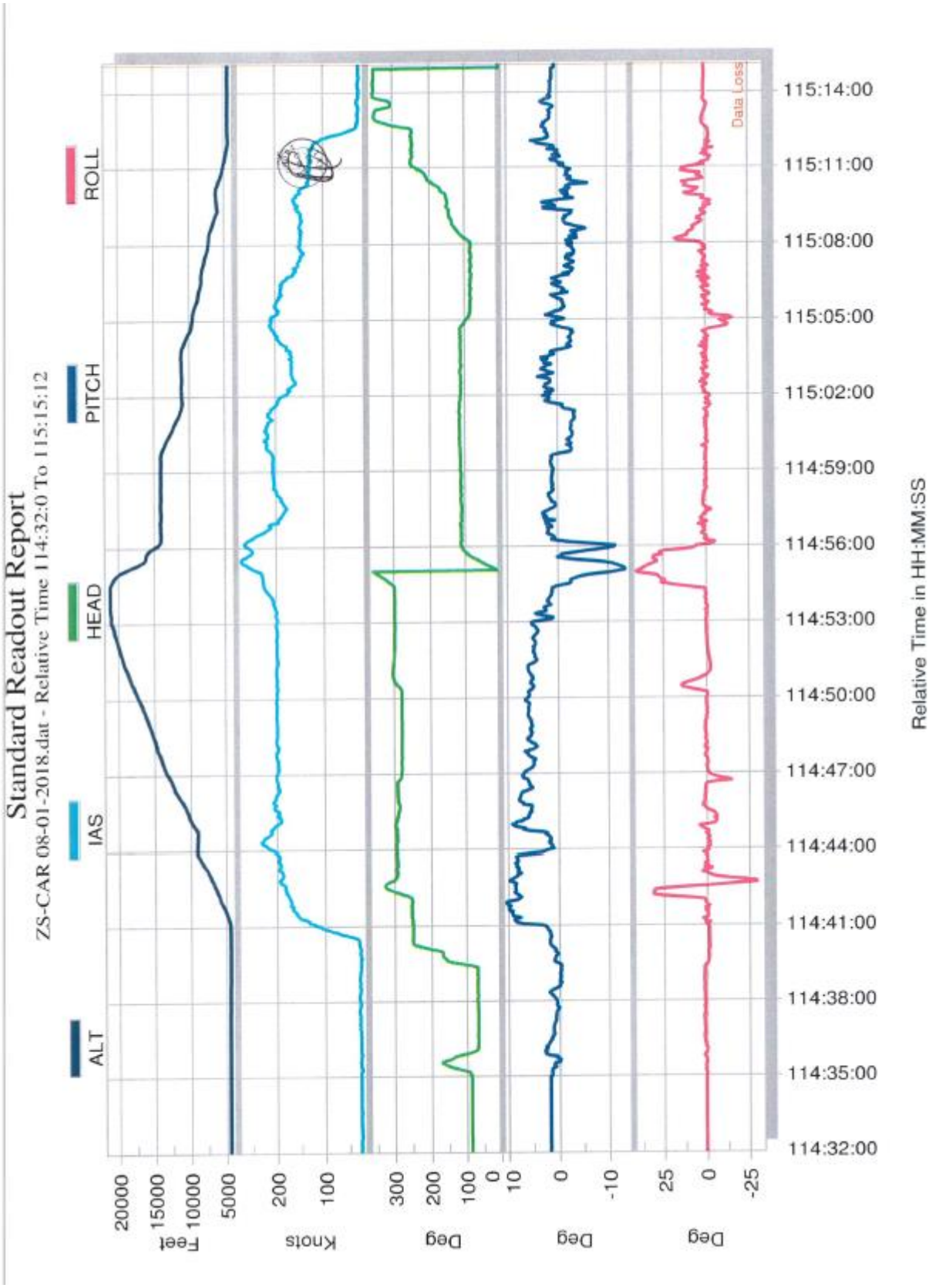
Standard Readout Report
ZS-CAR 08-01-2018.dat - Relative Time 114:32:0 To 115:15:12
ALT
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HEAD
PITCH
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Data Loss
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114:32:00
Relative Time in HH:MM:SS

Appendix H

FIU COMMENTS ON INCIDENT ZS-CAR 08 NOVEMBER 2019 AND RESPONSE FROM AIID

1. **FIU:** Paragraph 1.5.1.1: What is the relevancy of this paragraph in this investigation?

Response: We agree and have amended paragraph 1.5.1.1 which now reads:

1.6.1.1 Subsequent to this serious incident, ZS-CAR was involved in a fatal accident on 23 January 2020, which occurred during the investigation of this serious incident.

2. **FIU:** Paragraph 1.6.6 & 1.6.7: Are not the true reflection of what happened, what happened was after incidence of the 29th (27TH) November 2019, the FIU held an urgent safety board meeting. In that meeting it was decided that we will halt the operations as they were unsafe and the FIU requested the 2nd borescope which reflected the condition of the engine not airworthy to fly as the damage of the engine in question had gotten worse. The AMO wanted to still work on the engine after the incident and we told them to we suggest the second borescope, there was no incident to report on the 29 November as operations were halted by the Operator - 28 November (see attached Engine Incident Final Report).

Response: The facts in both paragraphs were stated by the AMO during an interview wherein FIU was represented. This is also stated in the AME's statement and is further supported by the dated stamp on the borescope pictures. See paragraphs 1.1.4, 1.6.2 to 1.6.7, as well as Figures 2 & 3. The statements in paragraph 1.6.6 and 1.6.7 are correct and AIID stands by them.

Update: The serious incident of 7 November 2019 was a reportable occurrence according to the flight folio number 679674 as this was recorded as a flight or intent to fly although the defect/incident occurred while the aircraft was still on the ground and prior to take off; the serious incident of 26 November 2019 was a reportable occurrence according to the flight folio number 68400; as this was recorded as a flight or intent to fly although the defect/incident occurred while the aircraft was still on the ground and prior to take off. The serious incident of 29 November 2019 was a reportable occurrence according to the flight folio number 67951 as this was recorded as a flight or intent to fly although the defect/incident occurred while the aircraft was still on the ground and prior to take off. In conclusion all incidents were reportable occurrences and investigators couldn't find any evidence that FIU had reported all these occurrences. The occurrence of 8 November 2019 was reported by ATNS to AIID. The investigators were informed by FIU management that the incident of 8 November 2020, the Captain filed the incident report, however, that report was never submitted to AIID.

3. **FIU:** Paragraph 3.2.8: It mentions that 3 incidents were not reported to AIID. Not true, original incident on 7th November was reported by the co-pilot. From the 8th November, after the 2nd Incident reported by the Captain and the AIID visit to the Execujet Hangar, I remained in constant contact with the Cyril George, the assigned Accident Investigator, via email and telephone. I have email trail/proof of such action. All aircraft documents requested by AIID were timeously supplied. On the 26/27 November, the aircraft was ground tested twice by the Flight Crew to check if aircraft was rectified and safe to fly. This was a precautional action, instituted by the Operator, to check if aircraft was in deed rectified as per Execujet's maintenance action and in part to clear the reported 8th November 2nd Incident Report. Engine failed both ground tests.

Emergency Safety Meeting was held the next day (28TH Nov) and Operator requested 2nd Borescope. All operations suspended on safety grounds. Once received from Execujet, the 2nd Borescope report and final engine diagnosis was sent Cyril on the 3rd December 2019.

Response: AIID was only informed about the serious incident of 8 November 2019 and had not been informed of any other incident notifications. The investigators learned about other incidents stated in the report during their investigation of the incident of 8 November 2019; and this is factual. The statement in paragraph 3.2.8 is correct and AIID stands by it. Also see paragraph 1.1.4 in the report.

Update: The serious incident of 7 November 2019 was a reportable occurrence according to the flight folio number 679674 as this was recorded as a flight or intent to fly although the defect/incident occurred while the aircraft was still on the ground and prior to take off; the serious incident of 26 November 2019 was a reportable occurrence according to the flight folio number 68400; as this was recorded as a flight or intent to fly although the defect/incident occurred while the aircraft was still on the ground and prior to take off. The serious incident of 29 November 2019 was a reportable occurrence according to the flight folio number 67951 as this was recorded as a flight or intent to fly although the defect/incident occurred while the aircraft was still on the ground and prior to take off. In conclusion, all incidents were reportable occurrences and investigators couldn't find any evidence that FIU had reported all these occurrences. The occurrence of 8 November 2019 was reported by ATNS to AIID. The investigators were informed by FIU management that the incident of the 8 November 2019, the Captain filed an incident report, however, that report was never submitted to AIID.

4. **FIU**: Paragraph 1.17.3: The engine in question was bought from the DAM and it was still under warranty, it made sense to consult with them as they were an authorise by the OEM to do maintenance on the engine type. True, after the 2nd incident, 8th November, the Operators first action was to request Execujet to seek outside assistance from Dallas Auto Motive and Cessna.

Response: AIID assumes that FIU intended to quote paragraph 1.17.4. The initial borescope recommended that the Operator/AMO consults the manufacturer and the Operator/AMO consulted a manufacturer-authorised agent. This is factual. Had the manufacturer been consulted, the Operator/AMO would probably had been given a different response as these types of failures could not be remedied in the field because they require the engine to be sent to the manufacturer for repairs. The statement in paragraph 3.2.8 is correct and AIID stands by it.

5. **FIU**: Paragraph 2.2.8: What relevancy does it have to the engine issue, as per CAMP records for ZS-CAR, the mandatory testing of the FDR was performed. Execujet could not provide proof that a download was performed. This has no bearing to the incident. FDR was found operating correctly as per fatal accident 23 January 2020.

Response: Although the paragraph has no bearing to this incident, it is, however, part of what was found during this investigation and identifies a non-conformance by the Operator to conduct an FDR annual test and download. The investigation also identified that some of the mandatory parameters were not tested in the last test undertaken on 8 January 2018. Having this statement in the report is correct and allowed by international standards and the AIID MOP.

6. **FIU**: Paragraph 2.2.9: I do not agree to this finding, away from base maintenance was in deed provide by Execujet. For all aircraft snags encountered when away from base,

the Captain consulted the MEL and if it was a “no go” item aircraft was grounded and maintenance engineer called to attend to the problem and certify aircraft as “Serviceable’’. As per FOM, Maintenance Contract and Maintenance Control Manual.

Response: It is a fact that the FIU aircraft when it was away from base scheduled maintenance required i.e. maintenance pre-flight inspection before the first flight of the day was not performed by a qualified AME as per the evidence provided by the operator and AMO on the flight folios. The pilots conducted the pre-flight inspection required from the crew in line with the flight operations manual (FOM). Therefore, it does not make it correct as per the CAR 2011 Part 43.02.2. The statement in paragraph 2.2.9 is correct and AIID stands by it.

7. **FIU**: Paragraph 2.2.10: When the crew arrived back at the base they gave the AMO to sort out the snags and the Captain cannot take the aircraft without being signed out (Ian please confirm the FF) True and reinforced at the February Safety meeting. (see attached February Safety meeting) I need to check the Flight Folio copies as per report to check if statement is indeed true.

Response: The statement in paragraph 2.2.10 is correct and is based on the flight folio copies sent to the investigating team by FIU and Execujet, see FF # 68372, 68379, 68388, 68393 and 68396. The statement in paragraph 2.2.10 is correct and AIID stands by it.

Update: Subsequent to FIU (Operator) receiving a draft final report of ZS-CAR Serious Incident, FIU resubmitted flight folios as stated in paragraph 1.17.6 where defects were signed off except for the flight folio 68396. The following were the investigators’ observations:

- All other multiple faults/snags in the operator’s flight folios were signed out and stamped individually by the engineers who corrected the faults/snags. However, in the flight folios stated in paragraph 1.17.6 that were resubmitted by the operator, the multiple faults/defects were signed out as a group using a single signature and a single stamp by the engineer who performed maintenance to rectify the faults/defects, this is being raised as in consistent of signing out the defects on the flight folios.

- Flight folio number 68396 had only one snag which had not been signed out since the crew registered it in the flight folio on 10 July 2019. As of the release of this report, the defect was still not signed out.

  The below flight folio is not part of what was resubmitted, however, this was observed:

  We further noted that flight folio 68393 which was previously submitted, the date of correcting the defect is the date before the defect occurred, the pilot logged/reported defects on the 5th however, defects were corrected on the 3rd of the same month and year.

- The defect logged in flight folio 68393 was signed out or corrected before the defect occurred. This possibly indicates an error in date entered in the flight folio since it is not possible to fix the defect before it had occurred.

8. **FIU:** Appendix B, what is the relevancy of it in this report? CVR was not required for aircraft type

Response: The CVR download would have enabled the investigating team to understand all the incidents and the communication between the two pilots during the incident. It was also found during the investigation that it is recommended by ICAO for this type of aircraft. The statement in paragraph 2.2.9 is correct and AIID stands by it.

9. **FIU:** I don't see anything that points out that the AMO sold the engine that was converted from the JT15D-4 to a JT15D-4B. and engine repair performed at time of conversion indicts similar damage as final diagnose as per CAA Incident.

Response: This is a commercial transaction which the operator accepted and has no bearing on the serious incident.

10. **FIU:** The engine did not indicate any excessive usage of oil before the incident. In fact the oil usage recording was discussed at the safety meeting held on the morning of the 7th November, before the 1st Incident, as I had noticed that Execujet was not recording oil replenishment during the pre-flight check. See attachment November Safety Meeting minutes.

Response: The FIU and the AMO did not have any method of recording and monitoring the oil consumption of both engines, and this is a fact. AIID stands by its statement on the lack of oil consumption monitoring by FIU and AMO.

11. **FIU**: There are differences in the 2 Borescope Report. First Borescope report indicated to Execujet/Dallas Air Motive engineers that it may be the Oil Scavenging Pump not clearing oil sufficiently, pump was replaced and the second report indicated that the engine had degraded with all the engine ground running and testing that heavy maintenance was required. Final conclusion to why the engine was leaking oil and failed was only received by the SACAA in April 2020 via report provided by Execujet/Dallas Air Motive, after engine was shipped to the USA and tear down by Engine Specialist (see attached Execujet Maintenance).

Response: The first borescope indicates that FIU/AMO should consult the manufacturer. However, FIU/AMO consulted Dallas Air Motive which advised that the problem may be the oil pump which was changed by the AMO. Both borescope inspections found oil in the engine as detailed in the report. AIID stands by its statement on the inclusion of both borescope reports.