AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

Reference:	CA18/2/3/10041

Aircraft Registration	ZS-SFV	**Date of Accident**	20 September 2021	**Time of Accident**	1840Z
Type of Aircraft	Learjet 35		**Type of Operation**	Private (Part 91)	
Pilot-in-command Licence Type	Airline Transport Pilot Licence (ATPL)		**Age** 47	**Licence Valid**	Yes
Pilot-in-command Flying Experience	**Total Flying Hours**		4736.6	**Hours on Type**	382.9
First Officer Licence Type	Airline Transport Pilot Licence (ATPL)		**Age** 40	**Licence Valid**	Yes
First Officer Flying Experience	**Total Flying Hours**		3459.7	**Hours on Type**	705.7

Last Point of Departure	Cape Town International Airport (FACT), Western Cape Province
Next Point of Intended Landing	Lanseria International Airport (FALA), Gauteng Province
Damage to Aircraft	Substantial

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

Runway 25 at FALA at Global Positioning System (GPS) co-ordinates determined to be 25°56'30.83" South 027°55'23.44 East, at an elevation of 4 420 feet (ft)

Meteorological Information	Surface Wind: 210° at 10kts, Temperature: 22°C, Clouds: Nil, Dew Point: 6°C, Visibility: 10km and QNH: 1020hPa						
Number of People On-board	2 + 3	**Number of People Injured**	0	**Number of People Killed**	0	**Other (On Ground)**	0

Synopsis

On 20 September 2021 at 1702Z, a Gates Learjet 35A aircraft with registration ZS-SFV departed Cape Town International Airport (FACT) for Lanseria International Airport (FALA) with two pilots and three passengers on-board. The private flight was conducted in instrument flight rules (IFR) by night and under the provisions of Part 91 of the Civil Aviation Regulations (CAR) 2011 as amended.

The crew reported that during the cruise, descent and landing phases to FALA, a sequence of defects occurred which interrupted their pre-landing checklist procedures. As a result, the landing gear lever was not selected down. Therefore, the aircraft was landed with landing gears up; it skidded on its belly and came to rest approximately 2 kilometres (km) from the threshold of Runway 25. All occupants were not injured during the accident sequence. The aircraft was substantially damaged.

Probable Cause

The crew forgot to lower the landing gear and the aircraft landed with the landing gears up (retracted). The aircraft had multiple instrument failures in-flight which increased the pilots' workload in the cockpit. This resulted in the pilots omitting to lower the landing gear and the aircraft landed with the landing gears up.

Contributory Factors:

- The crew was distracted by multiple recurring defects.
- The crew did not consult the pre-landing checklist.
- Unserviceable landing gear warning horn.
- Poor maintenance.

Occurrence Details

Reference Number	**:** CA18/2/3/10041
Occurrence Category	**:** Accident Category 1
Type of Operation	**:** Private Flight (Part 91)
Name of Operator	**:** Impuma Group (PTY) LTD
Aircraft Registration	**:** ZS-SFV
Aircraft Make and Model	**:** Gates Learjet 35 A
Nationality	**:** South African
Place	**:** Runway 25 at Lanseria International Airport (FALA), Gauteng Province
Date and Time	**:** 20 September 2021 at 1840Z
Injuries	**:** None
Damage	**:** Substantial

Purpose of the Investigation:

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

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

Investigation Process:

The Accident and Incident Investigations Division (AIID) of the South African Civil Aviation Authority (SACAA) was notified of the occurrence on 20 September 2022 at 1930Z. The occurrence was classified as an accident according to the CAR 2011 Part 12 and ICAO STD Annex 13 definitions. Notifications were sent to the State of Registry/Operator/Design/Manufacturer in accordance with CAR 2011 Part 12 and ICAO Annex 13 Chapter 4. The State of manufacturer appointed an accredited representative and advisor. Investigators dispatched to the accident site for this occurrence.

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

- *Accident — this investigated accident*
- *Aircraft — the Gates Learjet 35A involved in this accident.*
- *Investigation — the investigation into the circumstances of this accident*
- *Pilot — the pilot involved in this accident.*
- *Report — this accident report*

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

Disclaimer:

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ABBREVIATION	DESCRIPTION
AIID	Accident and Incident Investigations Division
AMM	Aircraft Maintenance Manual
AMO	Aircraft Maintenance Organisation
ATC	Air Traffic Control
ATPL	Airline Transport Pilot Licence
BAAI	Bureau of Air Accident Investigation
CAR	Civil Aviation Regulation
CDL	Configuration Deviation List
C of A	Certificate of Airworthiness
CRS	Certificate of Release to Service
CVR	Cockpit Voice Recorder
E	East
FACT	Cape Town International Airport
FALA	Lanseria International Airport
FAUT	Mthatha Airport
FDR	Flight Data Recorder
FT	Feet
FL	Flight Level
GPS	Global Positioning System
IAW	In Accordance With
ICAO	International Civil Aviation Organisation
IFR	Instrument Flight Rules
km	Kilometres
Kts	Knots
KIAS	Indicated Air Speed
METAR	Meteorological Aeronautical Report
MHz	Megahertz
PF	Pilot Flying
PM	Pilot Monitoring
PN	Part Number
QNH	Query Nautical Height
RWY	Runway
S	South
SACAR	South African Civil Aviation Regulation
SAWS	South African Weather Service
UTC	Co-ordinated Universal Time
VREF	Reference Landing Speed
Z	Zulu

1. FACTUAL INFORMATION

1.1. History of Flight

1.1.1 On 20 September 2021 at 1702Z, two pilots and three passengers on-board a Gates Learjet 35A aircraft with registration ZS-SFV took off on a private flight from Runway 19 at Cape Town International Airport (FACT) in the Western Cape province to Lanseria International Airport (FALA) in Gauteng province. The pilots filed a 1.6-hour flight plan with air traffic control (ATC) prior to departure. The private flight was conducted in instrument flight rules (IFR) by night and under the provisions of Part 91 of the Civil Aviation Regulations (CAR) 2011 as amended.

The captain was the pilot flying (PF), and the first officer was the pilot monitoring (PM). The accident flight was the pilot's first flight of the day. The pre-flight checklist was carried out with no anomalies detected. The pilots reported that the take-off at 1702Z was uneventful. According to the pilots, during the cruise phase of the flight, the following defects occurred:

- The left generator failed.
- The primary altimeter back light was unserviceable.
- The primary airspeed indicator back light was unserviceable.
- The emergency air indicator light was unserviceable.
- The hydraulic pressure indicator light was unserviceable.
- The left-side amp meter back light was unserviceable.

1.1.2 While commencing the descent to FALA, the master warning light illuminated on the instrument panel. As a result, the pilots decided to maintain Reference Landing Speed (V_{REF}) plus 10 knots (kts) to ensure that the aircraft maintained sufficient flying air speed to avoid entering a stall. The PF did not have an air speed indicator reading on his side of the cockpit because the back light on his air speed indicator was unserviceable (see Figure 1). Thus, the crew relied on the air speed indicator that was on the PM's side of the cockpit.

Moreover, the pilots could not swap their roles because there was another problem with the master warning light that had to be reset from the PM's side. The pilots then took a decision to retain control of the aircraft using the PF's side instruments.

1.1.3 At approximately 1747Z, the Johannesburg/Cape Town area control called ZS-SFV to check if everything was normal as they observed on radar that the aircraft was on a descent. The ZS-SFV crew responded that everything was normal. At approximately 1825Z during descent to FALA, the FALA radar control broadcasted that Runway 25 was in use and that it did not have precision instrument approach.

1.1.4 On final approach, the crew had initially elected to use instrument landing system (ILS) for landing on Runway 07. However, after the air traffic control (ATC) had confirmed the wind condition at FALA, which was 210° at approximately 10kts, the crew opted to undertake visual approach for landing on Runway 25. This was to avoid landing with excessive tail wind as they were maintaining V_{REF} speed plus 10kts (see FALA Airport Chart attached as Annexure A).

Figure 1: The air speed indicator backlight that was unserviceable.

1.1.5 Upon turning base leg, the pilots selected the flaps down to 45°, and at that stage, the augmentation aileron system on the aircraft failed. The pilots paid special attention to the air speed to avoid a stick pusher activation whilst dealing with the system failure which significantly affected roll of the aircraft. Furthermore, the PF was relying on verbal air speed readouts from the PM.

Note: Augmentation system: Source: Airplane Flight Manual (AFM) *"The augmentation aileron system is a system which employs the use of spoilers on top of each wing, to augment roll inputs in respect of the aircraft in all phases of flight, more critically during slow phases of the flights. The failure of this system significantly limits the roll control of the aircraft".*

1.1.6 The pilots further reported that the pre-landing checklist was interrupted by the accumulation of defects, and they had thought that all steps in the pre-landing checklist were followed. On base leg when the flaps were extended beyond 25° and the speed was approximately 125 knots indicated air speed (KIAS), the aural landing gear warning horn and the three red indication lights did not activate to indicate that the landing gear was not extended as stated in the Pilot's Operating Handbook (POH). The aircraft landed on its belly at 1840Z on Runway 25 and skidded for approximately 2 kilometres (km) before it came to rest on the right-side of the runway's centreline. At 1845Z, the landing gear warning horn activated after the aircraft had come to a stop. At 1851Z, one of the pilots was heard saying: "*Wheels. Lord, I forgot the wheels man*". Later, the crew admitted that the landing gear had not been selected to the down position and that the aircraft was landed with the undercarriage retracted.

1.1.7 All occupants were not injured during the accident sequence. The aircraft sustained substantial damage.

1.1.8 The accident occurred during night-time on Runway 25 at FALA at Global Positioning System (GPS) co-ordinates determined to be 25°56'30.83" South 027°55'23.44 East, at an elevation of 4 420 feet (ft).

Figure 2: The approximate skidding distance of the aircraft during the accident.
(Source: Google Earth)

1.2. Injuries to Persons

Injuries	Pilot	Crew	Pass.	Total On-board	Other
Fatal	-	-	-	-	-
Serious	-	-	-	-	-
Minor	-	-	-	-	-
None	2	0	3	5	-
Total	2	0	3	5	-

Note: Other means people on the ground.

1.3. Damage to Aircraft

1.3.1 The aircraft was substantially damaged during the accident sequence.

Figure 3: Damage to the underbelly and flaps.

1.4. Other Damage

1.4.1 The runway surface was slightly damaged.

Figure 4: Scratch marks on the runway surface at FALA.

1.5. Personnel Information

Pilot-in-command/Pilot Flying (PF)

Nationality	South African	Gender	Male	Age	47
Licence Type	Airline Transport Pilot Licence (ATPL)				
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	Instrument, Night rating and Instructor Grade 3				
Medical Expiry Date	31 October 2021				
Restrictions	Corrective lenses				
Previous Accidents	None				

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

Flying Experience:

Total Hours	4736.6
Total Past 24 Hours	1.6
Total Past 7 Days	4.4
Total Past 90 Days	4.4
Total on Type Past 90 Days	4.4
Total on Type	382.9

1.5.1 The PF was initially issued an Airline Transport Pilot Licence (ATPL) on 8 June 2011 in accordance with the South African Civil Aviation Regulations (CAR) Part 61. The PF's licence revalidation was carried out on 19 February 2021, and his licence was renewed on 9 March 2021 with an expiry date of 30 April 2022.

1.5.2 The PF was issued a Class 1 medical certificate on 13 October 2020 with an expiry date of 31 October 2021.

First Officer/Pilot Monitoring (PM)

Nationality	South African	Gender	Male	Age	40
Licence Type	Airline Transport Pilot Licence (ATPL)				
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	Instrument and Night rating				
Medical Expiry Date	31 May 2024				
Restrictions	None				
Previous Accidents	None				

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

Flying Experience:

Total Hours	3459.7
Total Past 24 Hours	1.6
Total Past 7 Days	4.7
Total Past 90 Days	24.7
Total on Type Past 90 Days	4.5
Total on Type	705.7

1.5.3 The PM was initially issued an Airline Transport Pilot Licence (ATPL) on 23 May 2011 in accordance with CAR Part 61. The PM's licence revalidation was carried out on 1 August 2021 with an expiry date of 31 August 2022.

1.5.4 The PM was issued a Class 1 medical certificate on 12 May 2021 in terms of Part 67. The PM's Class 1 medical certificate had an expiry date of 31 May 2024.

1.5.5 The PM was also issued a Class 1 and Class 2 electrocardiogram (ECG) certificates on 12 May 2021 with an expiry date of 31 May 2022.

1.5.6 The PM was issued an audiogram Class 1 and Class 2 certificates on 27 May 2019 with an expiry date of 31 May 2022.

1.5.7 The PM stated that on 14 October 2017, he was the pilot-in-command (PIC) on a Bombardier Challenger 6005 aircraft with registration ZS-TSN when the aircraft experienced weight-on-wheels input switch failure during the landing phase at FALA. No injuries were reported during that incident and the aircraft was substantially damaged. This occurrence could not be found on the Regulator's (SACAA's) database but was captured on the Bureau of Air Accident Investigation (BAAI) database.

Aircraft Maintenance Engineer (AME)

Nationality	South African	Gender	Male	Age	45
Licence Type	Aircraft Maintenance Engineer (AME)				
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	Gates Learjet 35 Series, Learjet 60 Series, Learjet 45 Series, Bombardier BD-100-1A10, Garrett Aire TFE731 Series, P & W PW305 and Honeywell AS907-1-1A				
Restrictions	None				
Previous Accidents	None				

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

1.5.8 The Aircraft Maintenance Engineer (AME) who signed out the defects, most of the work packs and Certificates of Release to Service (CRS) was initially issued an AME licence on 18 March 2009 by the Regulator in accordance with CAR Part 66. The AME's last revalidation was issued on 7 May 2021 with an expiry date of 27 March 2023.

1.5.9 The AME is a mechanic and is rated A (Airframe) and C (Engines) on Gates Learjet 35A aircraft.

1.5.10 Based on the AME's written statement, he carried out aircraft maintenance in accordance with (IAW) the Aircraft Maintenance Manual (AMM) (see Annexure B).

1.5.11 According to the aircraft maintenance records, the AME was undertaking the aircraft maintenance tasks and signing out work packs, including signing out X/W (Avionics) defects (see the regulation below). However, when the Avionics cards are signed out, a subcontractor would be referenced, or avionics documents would be attached on the job card. According to the Aircraft Maintenance Organisation (AMO), line maintenance control of defects and repetitive defects are rectified IAW the AMO's Manual of Procedure (MOP) (see Annexure C).

Authority to act as aircraft maintenance engineer

66.01.2 (*1) No person shall act as a maintenance engineer of an aircraft unless such person is the holder of a valid AME licence with the appropriate rating issued or validated by the Director in terms of this part.*

(2) The holder of an AME licence shall not exercise privileges other than the privileges granted by the licence and the appropriate rating held by such holder.

1.6. Aircraft Information

1.6.1 The accident aircraft was a Gates Learjet 35A, manufactured in the United State of America in 1979 by Gates Learjet Corporation. It was certified on 6 February 1980 and registered in South Africa on 17 June 2008. The aircraft is powered by two Honeywell TFE-731-2C-2B series turbofan engines with 3500 pounds of thrust which were installed on 15 August 1979. The aircraft has retractable landing gears. It has a range of 2 789 miles with a Jet A-1 fuel capacity of 931 gallons. The cabin has a volume of 268 cubic feet, and seats up to eight passengers.

Airframe:

Manufacturer/Model	Gates Lear Jet Corporation	
Serial Number	35A-275	
Year of Manufacture	1979	
Total Airframe Hours (At Time of Accident)	14 870.2	
Last Inspection (Date & Hours)	9 January 2021	14 850.8
Airframe Hours Since Last Inspection	19.4	
CRS Issue Date	9 January 2021	
C of A (Issue Date & Expiry Date)	8 July 2019	31 July 2022
C of R (Issue Date) (Present Owner)	18 November 2015	
Operating Category	Private Flight (Part 91)	
Type of Fuel Used	Jet A-1	
Previous Accidents	None	

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

1.6.2 The aircraft was first registered to the present owner on 18 November 2015. The aircraft's Certificate of Release to Service (CRS) was reissued on 9 January 2021 with an expiry date of 9 January 2022 or at 15150.8 hours, whichever occurs first.

1.6.3 The pilots reported that prior to the accident flight, they flew the aircraft twice on 17 September 2021 from FALA to Mthatha Airport (FAUT) and from FAUT to FACT. Both flights were uneventful except for a minor defect of the left generator warning light, which they were able to reset.

1.6.4 The last inspection carried out on the aircraft was a 300-hour inspection on 9 January 2021 at 14850.8 airframe hours. The aircraft had accumulated an additional 19.4 airframe hours in operation since the last inspection.

1.6.5 Major recurring defects were recorded in the aircraft's flight folio on pages 0413, 0414, 0417 and 0421. The defects were recorded as follows:

• On 10 January 2020, 29 June 2020, 27 January 2021, 18 April 2021, and 20 September 2021:

a) The autopilot did not track Navigation on GPS.

• On 27 January 2021, the test flight was carried out post-maintenance and it came back with the following defects:

b) Left-side engine was not reducing to idle when thrust lever was set to idle.

c) Augmentation aileron kept illuminating with full flaps.

• On 18 April 2021, the test flight was carried out by the manufacturer's pilot following a right-side leading-edge repair due to a bird strike which occurred on 14 February 2021; it came back with the following major defects:

d) Autopilot was unserviceable.

e) Left-side stall warning was switching on.

f) Altitude alert warning was unserviceable.

g) Landing gear horn was inoperative.

h) Weather radar required calibration.

i) Augmentation aileron right-side roll switches on at 5° and approximately 45°on the left-side.

g) Autopilot GPS Nav mode was unserviceable (intermittent).

1.6.6 The aircraft was on ground for approximately five months for repairs of the above and other defects. The post-maintenance test flight on 15 September 2021 was carried out by an independent pilot. No defects were reported, and the aircraft was released to service on 17 September 2021. As stated on paragraph 1.6.3, the aircraft was flown from FALA to FAUT and from FAUT to FACT.

• On 20 September 2021 during the accident flight from FACT to FALA, the following major defects were recorded:

a) Augmentation aileron failed when the flaps were set at 45°

b) Autopilot did not track Navigation

c) Left-side stall master warning activated

d) Left-side generator failed, amber caution illuminated

e) Emergency air indicator light unserviceable (see Figure 5)

f) Radar paints left low (see Figure 5)

g) Master landing gear warning unserviceable

Figure 5: Emergency air unserviceable and radar paints left.

Note: According to Minimum Equipment List (MEL), most of the above-mentioned defects fall under category "B" and "C" which ranged between 3 to 10 days (see Annexure C attached).

Category "B" Items in this category shall be repaired within three (3) consecutive calendar days (72 hours), excluding the day the malfunction was recorded in the aircraft flight folio.

Category "C" Items in this category shall be repaired within ten (10) consecutive calendar days (240 hours), excluding the day the malfunction was recorded in the aircraft flight folio.

1.6.7 According to available information, the owner had several meetings with the AMO to address the recurring defects and had asked the AMO to replace the entire looms of the aircraft. The investigation team found that the looms were not replaced in their entirety but only parts that related to the defects were replaced (see Annexure D CRMA).

Figures 6 & 7: New wires on the left, and old corroded wires on the right post-accident.

1.6.8 The aircraft had an aileron augmentation defect which was one of the safety concerns. It was signed out repeatedly.

1.6.9 The manufacturer stated that after installation, there is a requirement to carry out the adjustment/test which requires special tools part number: Spoileron Phase Detector Test Box 2671007-6) (Spoiler Phase Detect Box, Substitute for 2671007-6) 12835-001-001, to perform this task. The manufacturer further stated that typically, an operator or maintenance organisation would collaborate with Bombardier's Customer Response Centre to acquire the tools for the job as these tools are only available from the manufacturer. According to the manufacturer, no AMO in South Africa requested these tools during this period.

The aileron augmentation system works as follows: (Source - Manufacturer)

The aileron augmentation mode is engaged automatically when both flaps are extended below 25° AND the spoiler switch is in the retract position. A position sensor attached to each aileron provides an input to a computer-amplifier. The computer-amplifier controls two spoiler servo-valves located on a manifold assembly. When an aileron deflects up, its position sensor sends a signal to the computer-amplifier. The computer-amplifier then actuates the spoiler control valve, and the spoiler servo valves which extend the applicable spoiler at a 1:1 ratio with the aileron. A monitor circuit automatically disengages the augmentation system, illuminates an AUG-AIL light(amber) and retracts the spoilers when a system malfunction occurs. A SPOILERON RESET Switch will restore system operation if the malfunction has cleared itself. Normal spoiler operation overrides the augmentation modes. The augmentation mode disengages when the flaps are retracted above 25°.

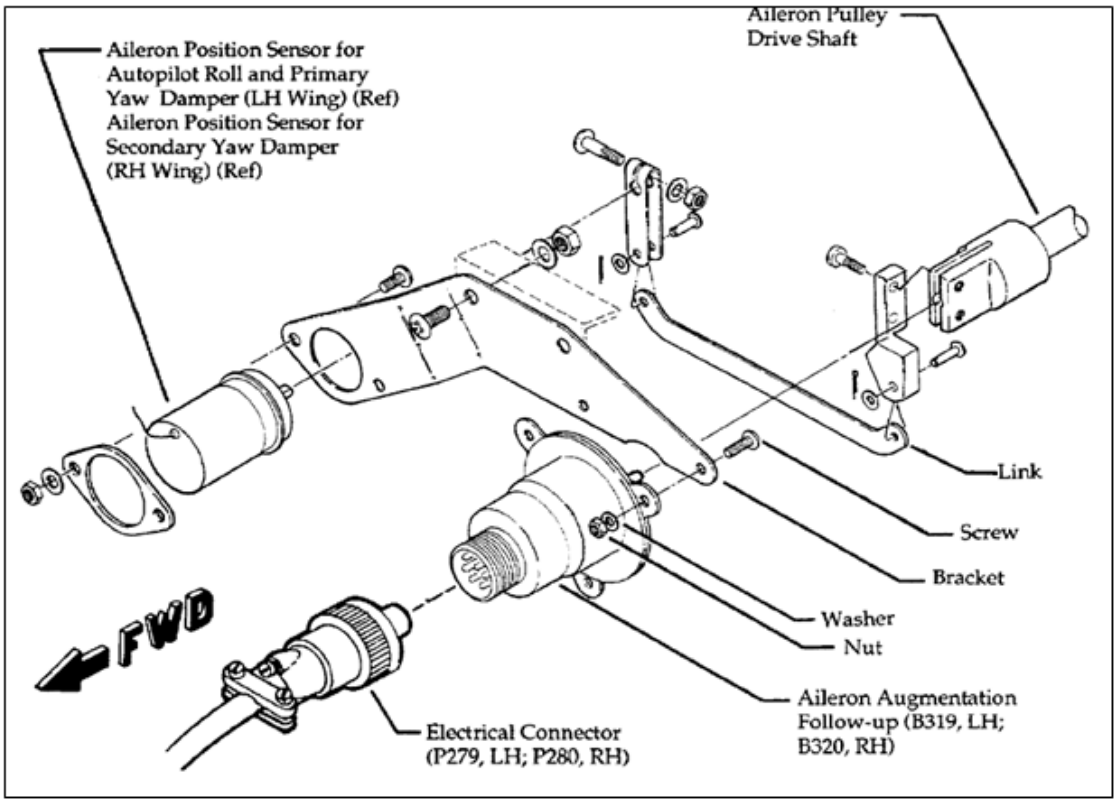


Diagram 1: Schematic diagram of the aileron augmentation.

Engine: 1

Manufacturer/Model	Honeywell
Serial Number	P-74762
Part Number	3070300-9
Hours Since New	13881.5
Hours Since Overhaul	97.6

Engine: 2

Manufacturer/Model	Honeywell
Serial Number	P-74759
Part Number	3070300-9
Hours Since New	14358.3
Hours Since Overhaul	20.8

1.7. Meteorological Information

1.7.1 A weather report was obtained from the South African Weather Service (SAWS). The information provided in the table below was obtained from the Meteorological Aerodrome Report (METAR) recorded at FALA on 20 September 2021 at 1900Z.

Wind Direction	210°	Wind Speed	10kts	Visibility	9999m
Temperature	22°C	Cloud Cover	Nil	Cloud Base	Nil
Dew Point	6°C	QNH	1020hPa		

1.8. Aids to Navigation

1.8.1 The aircraft was equipped with standard navigational equipment as approved by the Regulator (SACAA). There were no recorded defects with the navigational equipment prior to the flight. Defects started occurring during the cruise and descent phases.

1.9. Communication

1.9.1 The aircraft was equipped with standard communication equipment as approved by the Regulator for the aircraft type. There were no recorded defects with the communication equipment before and during the flight. The pilots last communicated with ATC on frequency 124.00-Megahertz (MHz).

1.10. Aerodrome Information

1.10.1 FALA is privately owned and is a controlled airport open to public air transport. It has one runway oriented 07/25.

Aerodrome Location	Lanseria, Gauteng Province
Aerodrome Status	Licensed
Aerodrome Co-ordinates	25°56.38'S 27°55.53'E
Aerodrome Altitude	4 520 feet AMSL / 1 377m
Runway Headings	Runway 07 065° Runway 25 245°
Runway Dimensions	Runway - 07/25 9 997x 148 feet / 3047 x 45 metres
Runway Used	25
Runway Surface	Asphalt
Approach Facilities	VOR/DME, NDB, ILS and RNAV.
Radio Frequency	124.00MHz, 121.65MHz and 123.7MHz

1.11. Flight Recorders

1.11.1 The aircraft was fitted with a flight data recorder (FDR) and a cockpit voice recorder (CVR) as required by the CAR 2011, Part 135.05.10. The recorders were removed from the aircraft on 20 September 2021 and were both successfully downloaded on 21 September 2021 at an approved AMO facility and in the presence of the investigators. The FDR was re-downloaded on 18 January 2023 by another approved AMO in the presence of the investigator.

FDR characteristics:

- Manufacturer: Lockheed Martin
- Type: Fairchild F-1000
- Part Number: S703-1000-00
- Serial Number: 01724
- Date of manufacture: April 1997

1.11.2 According to the FDR data, the installation of the 6-paramteter FDR system was carried out on 29 August 2008 and could only record the altitude, airspeed, heading, pitch, vertical/longitudinal acceleration, and time (see Annexure E)

According to the graph below, 10 minutes before landing, the aircraft was cruising at an altitude of 6545.5 feet at an indicated air speed of approximately 145 knots and heading of 29° (see graph 1).

Civil Aviation Regulations, 2011

Part 135

Air Transport Operations – Carriage of less than 20 Passengers or Cargo

Flight data recorders

135.05.10 (*1) An air service operator shall ensure that the aeroplane specified in Document SA-CATS 135 is equipped and operated with the FDR specified therein.*

(2) An operator shall ensure that the FDR required by subregulation (1) complies with the specifications prescribed in Document SA-CATS 135.

(3) The parameters of the FDR shall be determined to be within the ranges, accuracies and recording intervals as prescribed in Document SA-CATS 135 and, where required by subregulation (1), shall comply with the requirements of—

(a) a Type I/IA FDR capable of recording the parameters that accurately determine the aeroplane flight path, speed, altitude, engine power, configuration, and operation; or

(b) a Type II/IIA FDR capable of recording the parameters that accurately determine the aeroplane flight path, speed, altitude, engine power and configuration of lift and drag devices.

(4) No operator may operate an aeroplane equipped with a FDR using—

(a) metal foil;

(b) photographic film technology; or from 1 January 2016, magnetic tape.

TABLE D1
AEROPLANE AGE AND REQUIREMENTS

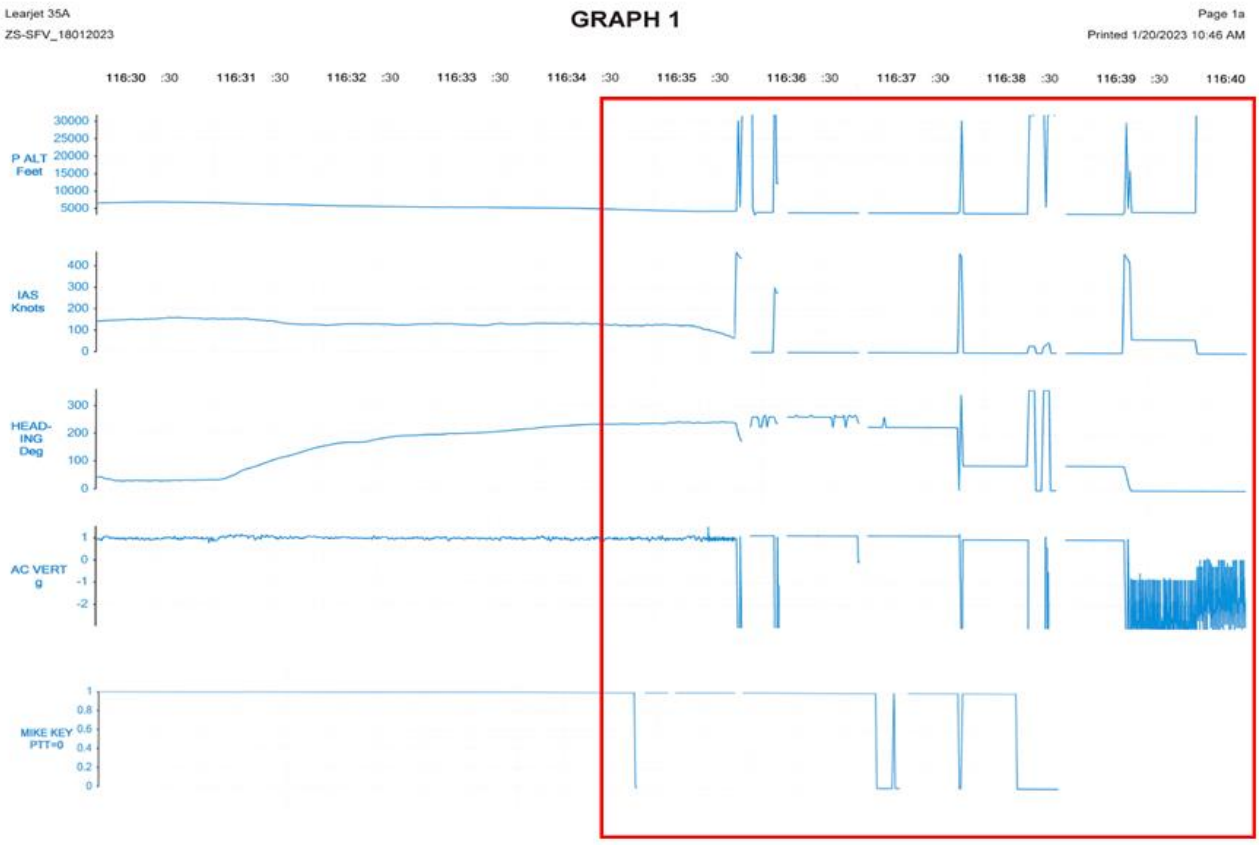
[Table D1 inserted by the Director of Civil Aviation through SA-CATS 2/2021 w.e.f. 15 November 2021.]

The weight of the aircraft (take-off mass)		Age of Aircraft	Parameters to be recorded by FDR
1	5700kg or Less	All turbine engine aeroplanes for which the individual Certificate of airworthiness is first issued on or after 01 Jan 2016.	(a) At least the first 16 parameters in the table in subsection 5 (10) (b) A class C AIR or AIRS which shall record at least the flight path and speed parameters displayed to pilots as defined in notes below the table or (c)

			An ADRS which shall record at least the first 7 parameters listed in the table in subsection 5 (11)
2	Over 27000kg	All aeroplanes for which the individual Certificate of airworthiness is first issued on or after 01 Jan 1989.	At least the first 32 parameters in the table in subsection 5 (10)
3	Over 5700kg up to and including 2700kg	All aeroplanes for which the individual Certificate of airworthiness is first issued on or after 01 Jan 1989.	At least the first 16 parameters in the table in subsection 5 (10)
4	5 700kg or less	All multi-engine turbine engine aeroplanes for which individual certificate of airworthiness first issued on or after 01 January 1990	At least the first 16 parameters in the table in subsection 5 (10)
5	Maximum 5700kg	All multi-engine aircraft for which individual airworthiness certificate is first issued on or after 01 January 1990	At least the first 16 parameters in the table in subsection 5 (10)
6	**Over 5700kg**	**All turbine-engined aeroplanes for which the individual certificate of airworthiness was first issued before 01 January 1989, with a maximum certificated take-off mass of over 5700 kg except those mentioned in item no 7 in this table**	**At least the first 5 parameters in the table in subsection 5 (10)**
7	Over 5700kg	All turbine engine aeroplanes, for which the individual certificate of airworthiness was first issued on or after 01 January 1987 but before 01 January 1989, except those mentioned in item no 7 in this table	At least the first 9 parameters in the table in subsection 5 (10)
8	Over 27000kg	Individual certificate of airworthiness first issued on or after 01 January 1987 but before 01 January 1989 types of which the prototype was certified by the appropriate authority after 30 September 1969	At least the first 16 parameters in the table in subsection 5 (10)
9	Over 27000kg	All turbine engine aeroplanes for which the individual certificate of airworthiness was first issued before 01 Jan 1987, but the prototype was certified by the appropriate authority after 30 September 1969	At least the first 05 parameters listed in the table in subsection 5(10) and meet the objectives of – (a) the attitude of the aeroplane in achieving its flight path; and (b) the basic forces acting upon the aeroplane resulting in the achieved flight path and the origin of such basic forces.
10	Over 5700kg	First individual airworthiness certificate issued on or after 01 January 2005	Record at least the first 78 parameters listed in the table in subsection 5(10)
11	Over 5700kg	All aeroplanes with a mass of over 5700kg Take Off Mass of which application for type certification is submitted to the contracting state on or after 1 January 2023	At least the first 82 parameters in the table in subsection 5(10)

CVR characteristics:

- Manufacturer: L3 aviation Products
- Type: FA2100
- Part Number: 2100-1020-50
- Serial Number: 001220852
- Date of manufacture: March



Graph 1: The red block shows the fluctuation of the instruments which occurred during the belly landing due to vibration as the aircraft scraped the runway.

1.11.3 According to the CVR recordings:

- The pilots did not perform pre-landing checklist.
- The pilots did not lower the landing gear and one pilot was heard saying he “forgot to lower the landing gear”.
- The warning horn did not sound; it only sounded after the aircraft had come to a stop.
- In the last 15 minutes of the flight, the pilots were mostly dealing with the defects of the aircraft (see Annexure F).

1.12 Wreckage and Impact Information

1.12.1 The aircraft touched down on the threshold of Runway 25 with the landing gears retracted; it skidded on its belly for approximately 2km in a nose-up attitude. There was no damage to the nose section. The accident occurred on a heading of approximately 240 degrees (°) magnetic (MAG).

Figure 8: The ZS-SFV aircraft as it came to rest on its belly on the runway. (Source: AMO)

1.12.2 On-site investigation found that the aircraft sustained damage to the flaps, antennae and underbelly.

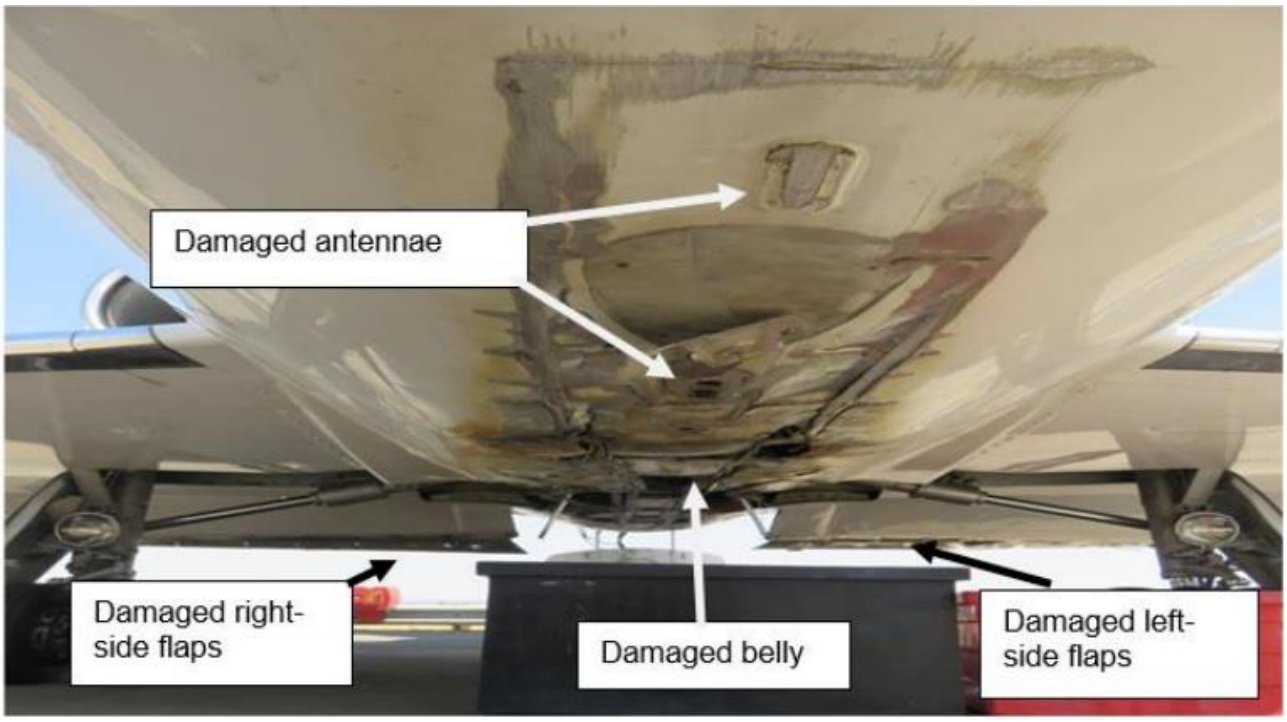


Figure 9: Aircraft damage post-accident.

1.12.3 According to the AMO, the landing gear lever was found in an up and locked position.

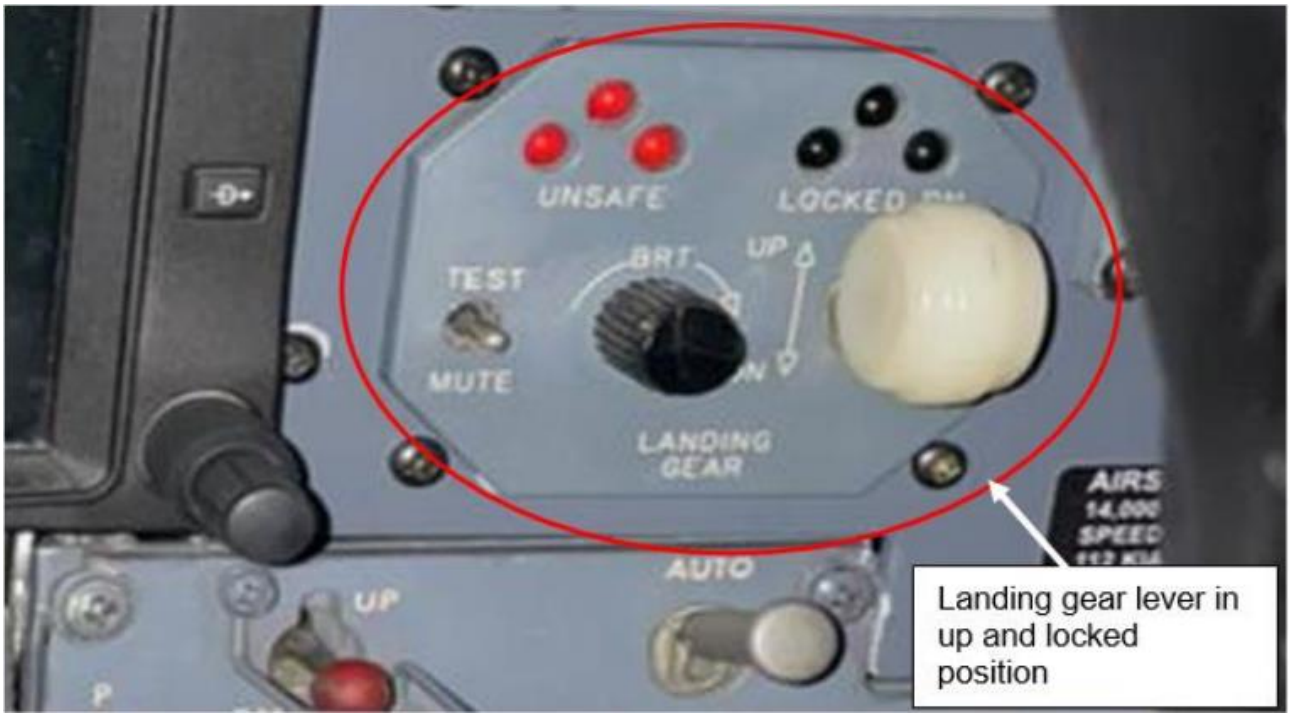


Figure 10: Landing gear lever in up and locked position. (Source: AMO)

1.12.4 The left- and right-side main landing gear doors were damaged during the accident sequence.

Figure 11: Damaged main landing gear doors.

1.12.5 All circuit breakers (CBs) were found in closed position.

Figure 12: All circuit breakers were in closed position after the accident.

1.13 Medical and Pathological Information

1.13.1 None.

1.14 Fire

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

1.15 Survival Aspects

1.15.1 The accident was considered survivable as no damage was caused to the cockpit and cabin structure of the aircraft.

Figure 13: Cockpit and cabin structure still intact.

1.16 Tests and Research

1.16.1 None.

1.17 Organisational and Management Information

1.17.1 The aircraft was operated privately under the provisions of Part 91 of the Civil Aviation Regulations (CAR) 2011 as amended. The aircraft had a valid Certificate of Airworthiness (C of A) that was issued by the Regulator on 8 July 2019 with an expiry date of 31 July 2022.

1.17.2 The Aircraft Maintenance Organisation (AMO) which carried out the last maintenance inspection (300-hour inspection) prior to the accident flight was in possession of an approved AMO certificate that was issued by the Regulator on 25 September 2020 with an expiry date of 31 October 2021.

1.17.3 The AMO which carried out the Avionics maintenance on the aircraft was in possession of an approved AMO certificate that was issued on 25 February 2021 with an expiry date of 28 February 2022.

1.17.4 The aircraft had recurring safety defects which were not permanently rectified, and no records showed that the AMO tried to seek assistance from the manufacturer regarding the defects. According to the AME's statement, *"defects rectifying is done after troubleshooting has been carried out IAW Maintenance Manual. If defects are listed on Flight Folio, same principle would apply but at times rectification would be summarised because of space issues. Signing off on the work pack would be done in detail after work has been carried out in-house or by a subcontractor with their release documents referenced".* See Annexure C.

1.18 Additional Information

1.18.1 Gates Learjet 35A Airplane Flight Manual (AFM)

Normal approach and before landing Checklist Procedure:

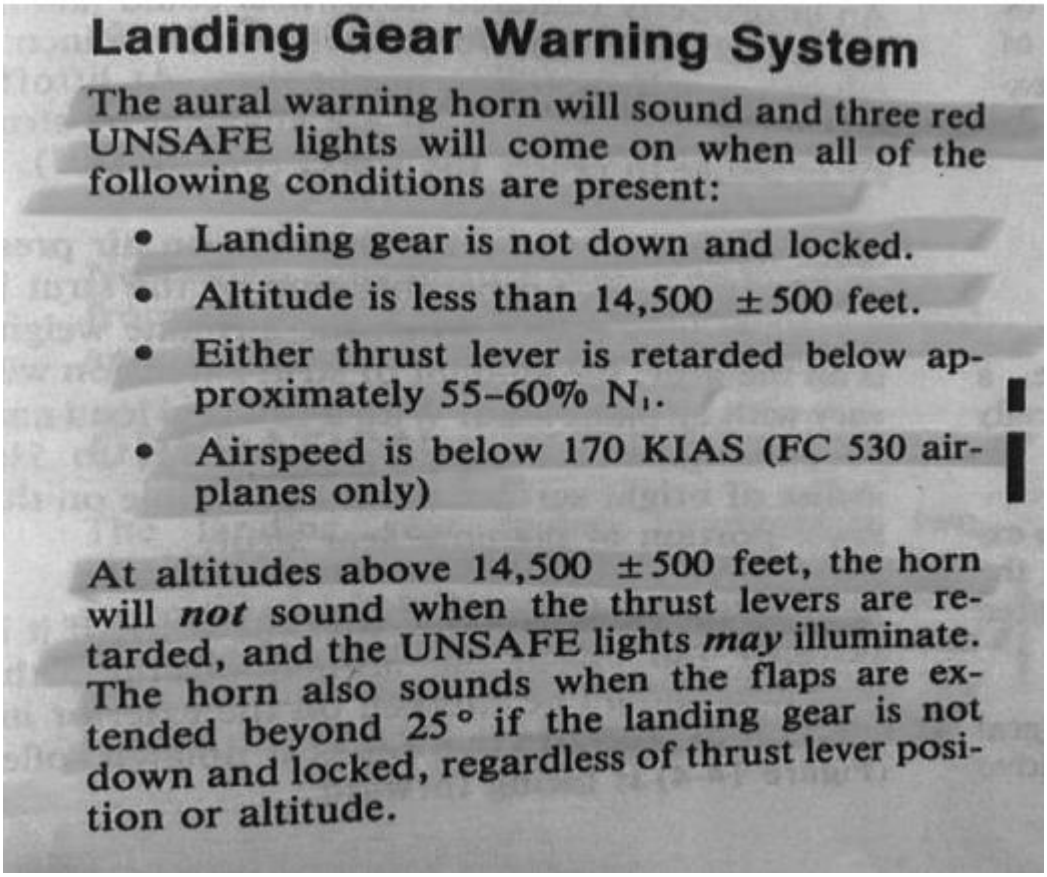
APPROACH (FL 180)

PNF	PF
Altimeters	_____SET
Bugs & V -Speeds	_____SET
Lights	ON
Fuel Balance	CHECKED
Circuit Breakers	CHECKED
Hydraulic & Emer Air	CHECKED
Seat Belt No Smoking Sign	ON
Radar Altimeter	ON
Air Conditioner	ON
Thrust Reverser	ARMED
FLT & NAV Instruments	SET & CHECKED

BEFORE LANDING

PNF	PF
Spoilers	RETRACTED
Landing Gear	DOWN
Landing Lights	ON
Parking Brake	OFF
Hydraulic Pressure	CHECKED
Anti-Skid	CHECKED-ON
Flaps	LAND
Air Ignition	ON
Engine Syncs	OFF
Yaw Damper	OFF

1.18.2 Gates Learjet 35A Airplane Flight Manual (AFM) Normal Procedure:



Landing Gear Warning System

The aural warning horn will sound and three red UNSAFE lights will come on when all of the following conditions are present:

- Landing gear is not down and locked.
- Altitude is less than 14,500 ±500 feet.
- Either thrust lever is retarded below approximately 55–60% N_1.
- Airspeed is below 170 KIAS (FC 530 airplanes only)

At altitudes above 14,500 ±500 feet, the horn will ***not*** sound when the thrust levers are retarded, and the UNSAFE lights ***may*** illuminate. The horn also sounds when the flaps are extended beyond 25° if the landing gear is not down and locked, regardless of thrust lever position or altitude.

1.18.3 According to the pilots, the landing gear horn did not sound prior to touch down, and it was not heard on the CVR recording. The landing gear horn was heard on the CVR recording after the aircraft had already landed on its belly.

1.19 Useful or Effective Investigation Techniques

1.19.1 Pilot Interview.
1.19.2 CVR Analysis.
1.19.3 Photos.

2. ANALYSIS

2.1. General

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

2.2. Analysis

2.2.1 <u>Man (Pilots)</u>

The pilots were properly rated and qualified to conduct the flight.

The PF had an ATPL that was issued on 9 March 2021 with expiry date of 30 April 2022. The

aircraft type was endorsed on the PF's logbook. The PF was issued a medical certificate on 13 October 2020 with expiry date of 30 October 2021 with no restrictions.

The PM had an ATPL that was issued on 1 August 2021 with an expiry date of 31 August 2022, and the aircraft type was endorsed on his logbook. The PM was issued a medical certificate on 12 May 2021 with expiry date of 31 May 2022 with no restrictions. Based on the Regulator's database, the PM had no accidents, incidents or violations in aviation and no record of any investigations pending against him. However, he stated that he had an incident on 14 October 2017 at FALA in which an aircraft had weight-on-wheels input switch failure during landing. Approximately 35:01 minutes into the flight, one of the pilots was heard on the CVR stating that he did not rest the previous day. Therefore, it is possible that one of the pilots was fatigued on the flight of 20 September 2022, however that did not contribute to the accident.

The AME had an AME licence that was issued on 7 May 2021 with an expiry date of 27 March 2023; the aircraft type was endorsed on his logbook. The AME was undertaking the aircraft maintenance tasks and signing out work packs, including signing X/W (Avionics) defects which was outside of his scope of licence privileges and limitations. Therefore, he contravened Part 66.01.2 of the South African CAR 2011 as amended.

2.2.2 Machine

The aircraft had recurring safety defects which were not permanently rectified, no records showed that the AMO tried to seek assistance from the manufacturer regarding the defects. According to the pilots, during the cruise phase of the flight, several unserviceable back lights defects occurred. It is possible that these lights had not been serviceable for some time and they were only noticed on this flight because it was night-time. The adjustment or testing of the augmentation aileron required tools that were only available from the manufacturer, however, there were no records that showed that these tools were requested from the manufacturer. The owner had several meetings with the AMO on which he requested the AMO to replace the entire looms, but only some of the looms were replaced. Redundant looms were removed, and some wires were stowed neatly behind the instrument panel (see Annexure D). On the base leg when the flaps were extended beyond 25°, the aural landing gear warning horn and three red indications did not activate as they were supposed to alert the pilots that they had omitted to properly configure the aircraft for landing. From the CVR recordings, the pilots were dealing with multiple defects which meant that their focus was on the accumulation of defects, hence, they forgot about the pre-landing checklist. Had the landing gear warning horn activated, it would have reminded them to lower the landing gears. The landing gear horn was heard from the CVR download, and it was after the aircraft had landed. One of the pilots stated that he forgot to lower the landing gear. The aircraft landed with the landing gears still retracted. The FDR download could only record 6 parameters as

per the SACAA modification approval; therefore, the investigation could not confirm the defects as reported by the pilots as there was no evidence to support the recorded defects.

2.2.3 Environment

Fine weather conditions prevailed at the time of the flight. The weather reported by SAWS was not considered to have had any bearing to this accident.

2.2.4 Mission

The flight was privately conducted in instrument flight rules (IFR) and under the provisions of Part 91 of the CAR 2011 as amended.

3. CONCLUSION

3.1. General

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

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

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

3.2. Findings

3.2.1 The PF had an ATPL and the aircraft type was endorsed on his licence. He also had a Class 1 aviation medical certificate that was issued on 13 October 2020 with an expiry date of 31 October 2021.

3.2.2 The PM had an ATPL and the aircraft type was endorsed on his licence. He also had a Class 1 aviation medical certificate that was issued on 5 May 2021 with an expiry date of 31 May 2024.

3.2.3 Based on the Regulator's database, the PM had no accidents, incidents or violations in aviation and no record of any investigations pending against him. However, he stated that he had an incident at FALA in which an aircraft had weight-on-wheels input switch failure during landing.

3.2.4 This was a private flight and was conducted in accordance with the provisions of Part 91 of the South African CAR 2011 as amended.

3.2.5 The aircraft was maintained by an approved and qualified AME with the aircraft type endorsed on his licence, which was initially issued on 18 March 2009. His last revalidation licence was issued on 7 May 2021 with an expiry date of 27 March 2023.

3.2.6 According to the aircraft maintenance records, the AME was undertaking the aircraft maintenance tasks and signing out work packs, including signing out X/W (Avionics) defects. Generally, when the Avionics cards are signed out, a subcontractor would be referenced on the job card, or avionics documents would be attached on the job card.

3.2.7 The aircraft was registered under the current owner on 18 November 2015. The aircraft was issued a Certificate of Airworthiness (C of A) on 8 July 2019 with an expiry date of 31 July 2022. The aircraft was reissued a Certificate of Release to Service (CRS) on 9 January 2021 with an expiry date of 9 January 2022 or at 15150.8 hours, whichever occurs first.

3.2.8 The AMO which carried out the last maintenance inspection (annual Inspection) prior to the accident flight had an approved AMO certificate that was issued by the Regulator on 25 February 2021 with an expiry date of 28 February 2022.

3.2.9 The AMO which carried out the avionics maintenance on the aircraft had an approved AMO certificate that was issued on 25 February 2021 with an expiry date of 28 February 2022.

3.2.10 The last mandatory periodic inspection (MPI) that was carried out on the aircraft was on 9 January 2021 at 14850.8 airframe hours. The aircraft had accumulated an additional 19.4 airframe hours in operation since the last inspection.

3.2.11 The owner had several meetings with the AMO addressing the recurring defects and had requested that the entire loom be replaced. However, only parts of the looms were replaced.

3.2.12 The aircraft had recurring safety defects which were not permanently rectified, and no records showed that the AMO tried to seek assistance from the manufacturer regarding the defects.

3.2.13 The aircraft was fitted with a CVR and FDR as it is a requirement according to CAR 2011 Sub-part 135.05.11. The recorders were both successfully downloaded on 21 September 2021 at an approved AMO facility in the presence of the investigators.

The FDR download could only record 6 parameters as per the SACAA modification approval; therefore, the investigation could not confirm the defects as reported by the pilots as there was no evidence to support the recorded defects.

3.2.14 Two independent pilot conducted the tests flights on different dates, and both reported similar defects. These defects were rectified and signed by the AMO responsible for the maintenance of the aircraft.

3.2.15 On the base leg when the flaps were extended beyond 25°, the aural landing gear warning horn and three red indications did not activate as they were supposed to, to alert the pilots that they had omitted to properly configure the aircraft for landing.

3.2.16 The pilots were flying the aircraft visually during the approach phase while dealing with a stall actuation warning, had no reference to an air speed indicator on the PF's side and the augmentation aileron system had failed which is a critical system when the aircraft is on approach and reducing speed.

3.2.17 There is a probability that one of the pilots was fatigued, as he did not rest the previous day.

3.2.18 The crew admitted that the landing gear had not been selected in the down position and the aircraft landed with the undercarriage retracted. The aircraft landed on its belly on RWY 25 and skidded for approximately 2 kilometres (km) before it came to rest on the right-side of the runway's centreline.

3.2.19 The reported weather by SAWS did not have a bearing to this accident.

3.3. Probable Cause

3.3.1 The crew forgot to lower the landing gear and the aircraft landed with landing gears up. The aircraft had multiple instrument failures in-flight which increased the pilots' workload in the cockpit. This resulted in the pilots omitting to lower the landing gear and the aircraft landed with the landing gears up.

3.4. Contributory Factors

3.4.1 The crew was distracted by multiple recurring defects.

3.4.2 The crew did not consult the pre-landing checklist.

3.4.3 Unserviceable landing gear warning horn.

3.4.4 Poor maintenance.

4. SAFETY RECOMMENDATIONS

4.1. General

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

4.2. Safety Recommendation/s

4.2.1 None.

5. APPENDICES

5.1 Annexure A - FALA chart

5.2 Annexure B - AME's statement

5.3 Annexure C – AMO's MOP

5.4 Annexure D - CRMA

5.5 Annexure E – Logbook entry of FDR installation

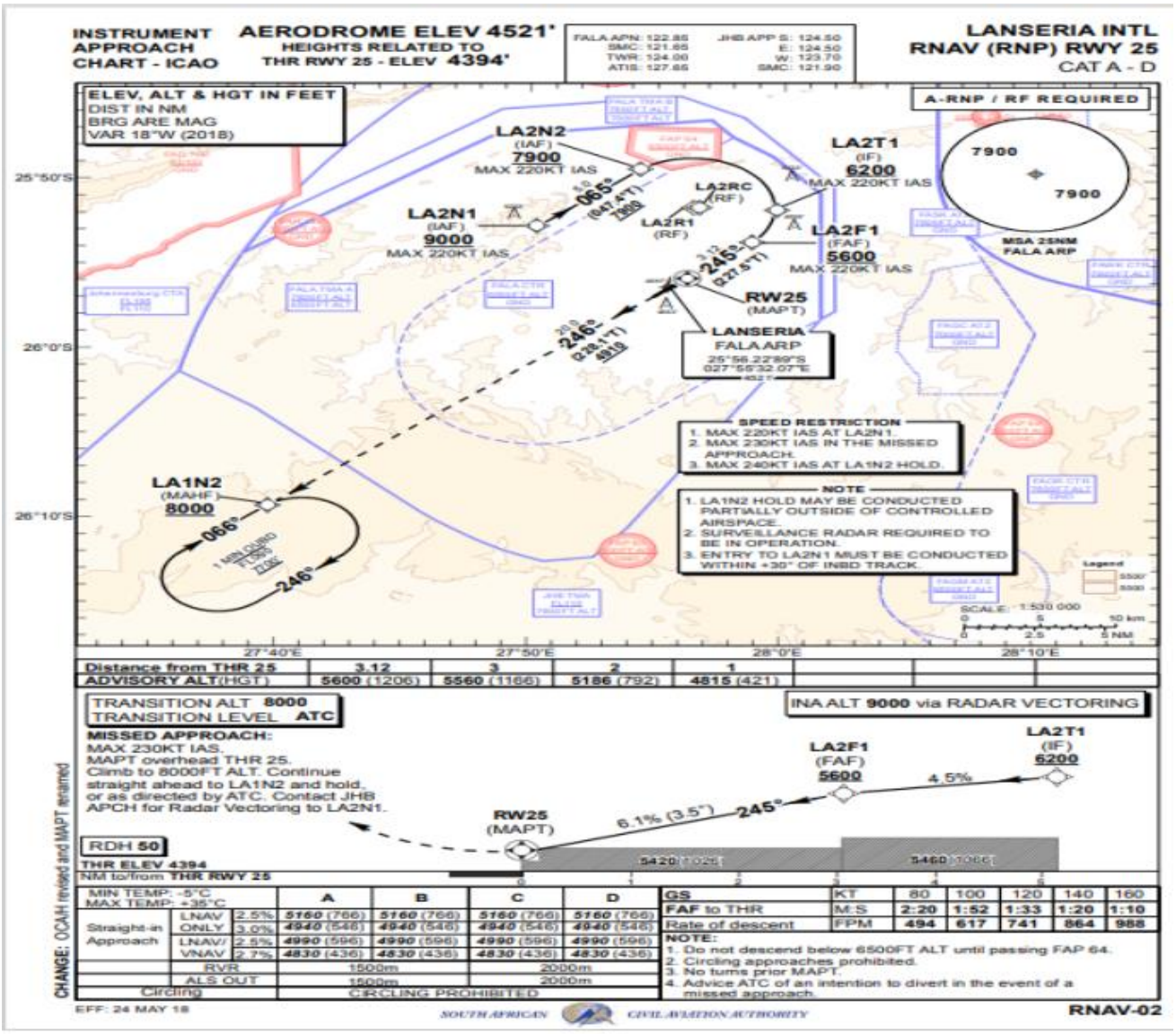
5.6 Annexure F – CVR transcript

5.7 Annexure G – MEL

This report is issued by:

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

Annexure A



Annexure B

"Defects rectifying is done after troubleshooting has been carried out I.A.W Maintenance Manual. If defects are listed on Flight Folio, same principle would apply but at times rectification would be summarised because of space issues. Signing off on the work pack would be done in details after work has been carried out in house or by subcontractor with their release documents referenced."

Annexure C

L2.3 Line Maintenance Control of Defects and Repetitive Defects - Defects arising during Line Maintenance activities may fall into two categories, those that affect the airworthiness of the aircraft and require immediate rectification and those that may be deferred to a more suitable time for rectification. All defects, regardless of their status, will be recorded in the relevant maintenance records (Work packs, non-routine aircraft/engine work order traveller/discrepancy sheets, flight folios etc.) as well as the corrective actions implemented to rectify (or defer) such defects. A review of repetitive defects should be taken of the log entries, with the crew or maintenance controllers for those previous actions taken and to aid in troubleshooting. When processing Parts or Equipment required being purchased/delivered in order to rectify an Aircraft on Ground (AOG) emergency, such processing shall be done in accordance with procedure in the MOE. All deferrals will be carried out in accordance with the approved Minimum Equipment List (MEL) or Configuration Deviation List (CDL) and those procedures concerning the deferment in consultation with the aircraft operator. Due regard will be made of current MEL OPEN deferred defects and tech log analysis to ensure the airworthiness of the aircraft is not affected, or undue load placed on the crew due to multiple systems being inoperative. Only those deferrals will be carried out which are within the limitations specified in the relevant maintenance manuals and the Operators approved MEL including those procedures listed in the relevant MEL required about Maintenance, Operations and Placarding. It shall remain the responsibility of an Engineer issuing a Release to Service to determine if a defect may be considered a Reportable Occurrence under the SACAA System of Technical Occurrence Reporting or bring to the attention of the Compliance Manager the details in order to make that determination. In each case, he shall prepare a report of the details and forward onto the CM per MOE 02 L2.4 Line Procedure for Completion of Technical Log, the Technical/Journey Log, is the property of the Owner/Operator of the aircraft. Technical/Journey Logs are usually specific to each Owner/Operator and the procedure for completion is particular to the Owner/Operator. However, as a minimum, an entry in the relevant Technical Logbook shall be made by the Certifying Engineer, referring to any work order/pack raised, in which work was performed on that aircraft as per MOE 2.13 and 2.16. EMS will ensure that specific instructions (if any) from the Owner/Operator regarding the completion of Technical/Journey Logs are obtained and implemented for those Part 02L Line Maintenance M A N U A L Doc. No: Issue: Revision: Date: Cover: SA-MOE-02L 05 01 15 Mar 2021 Page 5 of 7 Contracting Operators listed as per this MOE. Details of those procedures will be referred to and incorporated into the continuation training program for relevant Certifying Staff and Planners to ensure up-to-date knowledge and application of such. Copies of the Technical/Journey Logs will be retained in accordance with Operators approved MCM when so contracted. In all cases, the Certifying Staff will ensure that the following is clearly detailed on the CA 12-14a 20 November 2020 Page 29 of 29 Technical/Journey Log: a) The CRS/CRMA Statement or abbreviated statement; b) The AMO Approval number of MRO

Services (Pty) Ltd; c) The Certifying Staff Authorization number and; d) Name/Signature of the Certifying Staff; e) The flight times/cycles and dates are clearly annotated in the area relevant to the work to be released. If, due to the nature of the defect, a duplicate inspection is required, that inspection will be detailed in the Technical Log, when a work pack is not available for such activities. L2.5 Line Procedure for Pooled Parts and Loan Parts of parts common to the aircraft or fleet of aircraft being operated. These customers/operators may contract EMS to store and distribute parts in accordance with Owner/Operator but in all other respects will be subject to the full extent of EMS Procedures, including the robbing of parts, and goods receiving (Away from Base) as and if applicable. Due regards must be taken to ensure that Modification Standards and Airworthiness Directive Compliance requirements are being met. L2.6 Line Procedure for Return of Defective Part Removed from Aircraft During Line Maintenance, occasions may arise where

defective parts and/or components are required to be removed from an aircraft. In this case, the Customer/Operator may exercise the option to: Have the Maintenance Organization replace (repair and refit) the affected part, or have the affected part sent for repair to their facility and/or approved contractor.

Annexure D

CRMA 37423

This constitutes an official Logbook entry and must be affixed in the appropriate Logbook.

Aircraft	Registration	Serial Number
Gates Learjet 35A	ZS-SFV	275

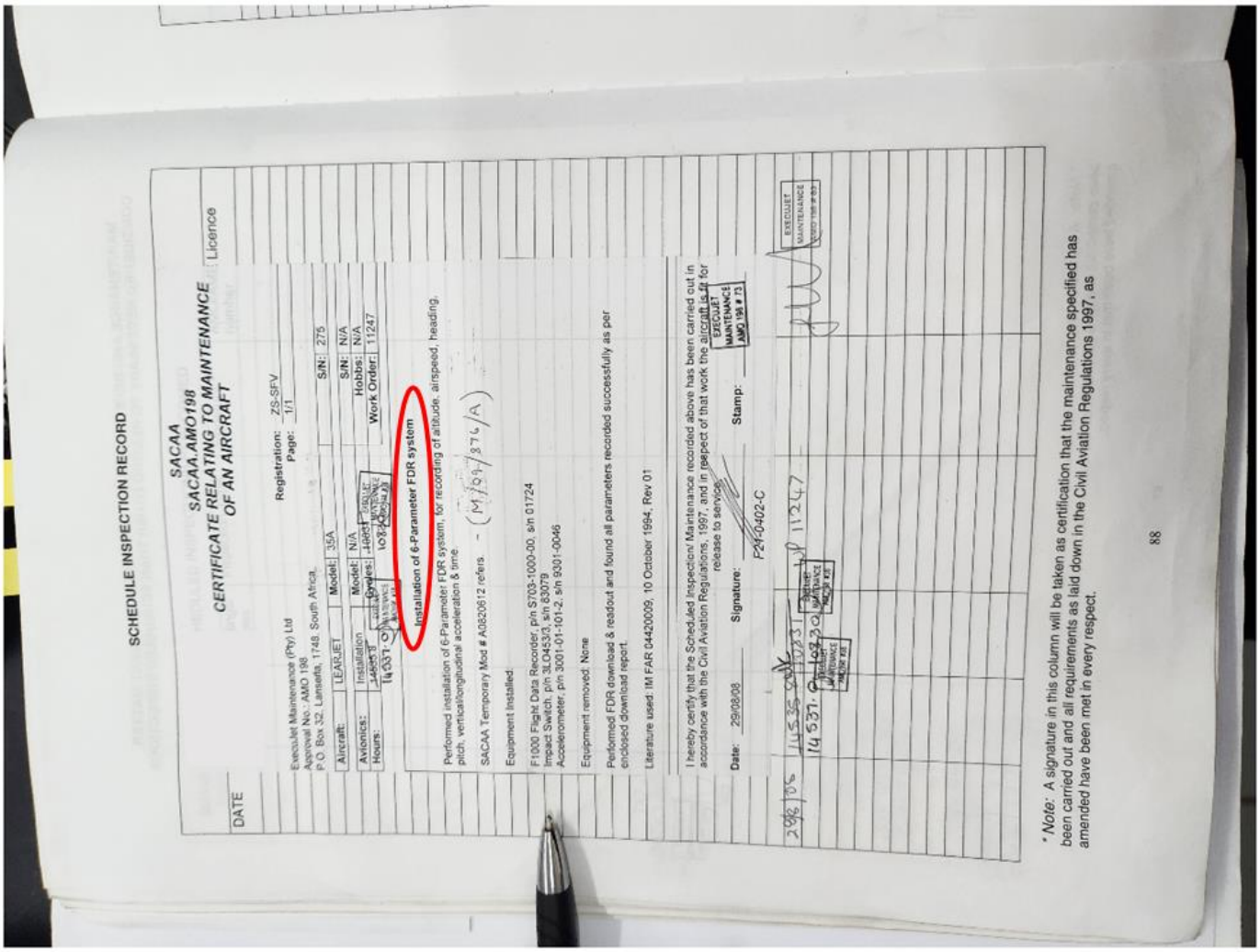
Removed redundant bagged and stowed wiring and neatened up looms behind the instrument panel.

Work carried out IAW Manufacturers MM MM-99 (rev: 7 Mar 15/18)

Manual Number: MM-99 Revision: 7 Mar 15/18

I hereby certify that in carrying out the maintenance above, all the requirements prescribed in the South African Civil Aviation Regulation, as amended which are applicable thereto have been complied with.

Annexure E



SCHEDULE INSPECTION RECORD

SACAA
SACAA AMO198
CERTIFICATE RELATING TO MAINTENANCE OF AN AIRCRAFT

Licence

DATE

Registration: ZS-SFV
Page: 1/1

Execujet Maintenance (Pty) Ltd
Approval No.: AMO 198
P.O. Box 32, Lanseria, 1748, South Africa.

S/N: 275

Aircraft: LEARJET | Model: 35A

Avionics: Installation | Model: N/A | S/N: N/A
Hours: 14631 | Cycles: 14651 | Hobbs: N/A
Work Order: 11247

Installation of 6-Parameter FDR system

Performed installation of 6-Parameter FDR system, for recording of altitude, airspeed, heading, pitch, vertical/longitudinal acceleration & time.

SACAA Temporary Mod # A0820612 refers - (M709/376/A)

Equipment Installed:

F1000 Flight Data Recorder, p/n S703-1000-00, s/n 01724
Impact Switch, p/n 3L0453/3, s/n 83079
Accelerometer, p/n 3001-01-101-2, s/n 9301-0046

Equipment removed: None

Performed FDR download & readout and found all parameters recorded successfully as per enclosed download report.

Literature used: IM FAR 04420009, 10 October 1994, Rev 01

I hereby certify that the Scheduled Inspection/ Maintenance recorded above has been carried out in accordance with the Civil Aviation Regulations, 1997, and in respect of that work the aircraft is fit for release to service.

Date: 29/08/08 Signature: P24-0402-C Stamp: EXECUJET MAINTENANCE AMO 198 # 73

29/8/08 14631 11247

EXECUJET MAINTENANCE AMO 198 # 73

*Note: A signature in this column will be taken as certification that the maintenance specified has been carried out and all requirements as laid down in the Civil Aviation Regulations 1997, as amended have been met in every respect.

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Annexure F

20:29	PM	PF	Check die airspeed, hoekom het julle die pas daai ding? Gaan hy bietjie? Check the airspeed why did they not match? Is it going a little bit?
20:36	PF	PM	Nee nee nee vok nie dit No no no not that
20:40	PM	PF	maak nie daar saak nie It doesn't matter.
20:53	PF	PM	Ons God Die maan is mooi he Our God. The moon looks beautiful hey
21:57	PM	PF	Aaa ek probeer eintlik sien laat ek my foon kan gryp Aaa I am trying, let me see if I can take my phone
22:00	PF	PM	Die Kompas The compass?
22:02	PF	PM	Wag laat ek myne gryp Wait let me take mine
22:06	PM	PF	Het jy hom Did you get it?
22:24	PF	PM	Ja Yes
22:30	PM	PF	Ko mons kyk ma wat maak hy as ons op gelyn het Let's see what it does when we are lined up
22:34	PF	PM	Ja Yes
22:36	PM	PF	Ja straight ahead klim 9000ft transponder is klaar aan Radar is op standby ek gaan hom daar los. Yes, straight ahead climb to 9000ft the transponder is already on. Radar is on standby, and I will leave it there.
22:40	PF	PM	Hy gaan vir jou gee 125 135 After departure bly 119. Ag 121.9 It will give you 125 135 After departure remain 119 decimal ag 121 decimal 9
23:00	PM	PF	Hai khona la No ways
24:45	PF	PM	Waar is ons target? 958 die N1 ne? OK Where is our target 958 the N1 ne? Okay
24:58	PM	PF	Ek sien di voken taxi ligte nie werk nie I see the taxi lights are not working
24:59	PF	PM	Ja Yes
25:00	TWR	SFV	SFV RWY 19 cleared for take-off wind 190 degrees 15 knots
25:06	SFV	TWR	Thank you cleared take-off SFV
25:19	PM	PF	Take off time 1702

26:43	PF	PM	Maar die flight director op gee nie But the flight director is not transmitting
26:54	APP	SFV	SFV good evening to you passing 9400ft under radar control climb to FL150
26:58	SFV	APP	Thank you climbing 150 SFV
27:00	PM	PF	Okay 150 is set ek gooi standard vir jou Okay 150 is set I put a standard for you
27:01	APP	SFV	SFV vectors enroute, turn left heading 090
27:15	SFV	APP	Left heading 090 SFV
27:18	PM	PF	Ok 090 ek gee vir jou heading soos jy wil he Daarsy mooi gooi 832 Okay 090 I am giving you heading as you want There we go nice put 832
27:40	PF	PM	Jy kan nie hierdie airspeed check nie? Hy gaan vokop ne? You can't check the airspeed, its going to mess up?
27:41	PM	PF	Ja Yes
30:19	PF	PM	Left turn ja maar hierdie ding draai hoe kom draai dit, want jy het nav getrek? Left turn, yes but this thing is turning why is it turning? Is it because you moved over to nav?
30:22	PM	PF	Ja jy is op nav oh nee jy is op V lock Yes, you are on nav, oh no you are on V lock.
30:27	PF	PM	Ja gee vir jou direct OKLOK Yes, I am giving you direct to OKLOK
30:29	SFV	CTN	Cape town good day SFV passing 135
30:34	CTN	SFV	ZS-SFV Cape town good day climb to 390 route direct APLIN
30:40	SFV	CTN	390 direct APLIN SFV
30:42	PM	PF	390 direct APLIN
30:50	PF	PM	Waar is voken APLIN Where is APLIN Is dit daar bo? Is it there on top? Was dit al daar? Was it always there?
30:51	PM	PF	Ja Yes Check hoe maak die lig Check what is that light doing
30:55	PF	PM	Gaan jy vir my heading gee? Are you going to give me heading?
30:59	PM	PF	OK Ja ek gaan vir jou gee jy is presis daar 067 Yes, I will give you, you are precisely there 067
31:07	PF	PM	Kan dit net heading kry Can it just get the heading? Check hoe maak hy draai nou weer Look how its doing its turning again
31:10	PF	PM	Die baalitjie sit reg now The ball is sitting correctly now

33:31	PM	PF	Ek gaan nou nav weer try, okay? I am going to try nav again, okay?
33:32	PF	PM	OK Circuit of the day Hy capture reg nou, nou moet ek dit arm 71 71 60 Daar is hy
33:58	PF	PM	Moet nou links draai? Must I turn left now?
33:59	PM	PF	Jy moet 067 direk You must go to 067 direct
34:01	PM	PF	Ek gaan hom 6 maak I am going to make it 6 Hy is klaar now stop hy uit Its done now, is it stopping out
34:24	PM	PF	Onthou nou wag daai een is daai in die boek Remember now, wait that one is it in the book
34:52	PM	PF	Ek is moeg tjom. I am tired now chom I am not gonna lie. I don't lie
34:58	PF	PM	I don't let nothing
35:01	PM	PF	Ek moes eintlik gister net gevoken le en slap, slaap op genoeg. Yesterday I should have slept and slept enough Voken slaap en nog slaap en as jy aan kom drink 'n slaap pile n voken nog slaap. Sleep and sleep some more when is wake up, drink a sleeping pill and sleep more.

36:15	PM	PF	Daai ligte werk ook nie Those lights also don't work
36:17	PF	PM	Ja Yes
36:26	PM	PF	Jy sien hierso wat hulle se hierdie ding se vir jou nie wat se een is die gage nie You see what they say here, they don't tell you which one is the gauge
36:34	PF	PM	Ja ja Yes yes
36:35	PM	PF	Dis hoekom daai ene moet werk That's why that one must work
36:36	PF	PM	Ja Yes
36:39	PM	PF	Dat jy kan sien di moji gesien het So that you can see the moji
36:41	PF	PM	Wat dan kan jy nie What then if you can't?
36:54	PF	PM	Wat klim ons nou 74? What is our rate of climb now 74?
36:55	PM	PF	Nee point 70 No point 70 Dit is slim nou weer It is smart now again
36:58	PF	PM	Ja Yes Gedraai Turned
37:50	PF	PM	Daai drie nie lig nie? Those three do not light
37:57	PM	PF	Nee gee die temperature nie No, it is not giving the temperature
38:07	PM	PF	Voken kak as dit so skyn ne? It is terrible when it shines like this
38:08	PF	PM	Ja
			Yes
38:11	PM	PF	Kyk hoe skyn hy? Look how it shines?
40:49	PM	PF	Hoe lank vir daai operasie tjom How long for that operation chom?
40:50	PF	PM	Jy gaan in is alright… You go in its alright…
40:53	PM	PF	Met narkose? With anesthetics?
40:59	PF	PM	Ja jy het narkose Yes, with anesthetics Ek het niks ge se vir my aviation dokter nie 'n word nie gaan net I didn't say anything to my aviation doctor not a word I just went. En dan die herstel is lank The recovery is long

41:38	PM	PF	So is net sop So its just soup
41:43	PF	PM	Ja niks in gaan nie Yes, nothing goes in Ek het op yogisip ge… I just drank yogisip
41:55	PF	PM	Jy kan nie eers sop drink You can't even drink soup
42:01	PM	PF	Ginuwine Ginuwine
42:02	PF	PM	Jy kan nie sluk nie niks nie You can't swallow nothing at all
42:03	PM	PF	Is dit seer of? Is it sore or?
42:05	PF	PM	Nee hy werk nie No, it does not work
42:30	PM	PF	Jy raak honger honger You must be hungry hungry
42:43	PF	PM	Energade en en en yogisip Energade and yogisip
43:07	PF	PM	Bro kan jy my boekie agter my haal Brother can you take my book out behind me?
43:09	PM	PF	Wat se boek? What book?
43:11	PF	PM	Die flight folio The flight folio
43:13	PM	PF	Nee ek het hom ge…. No, I ….
43:19	PF	PM	So hierdie ding capture nie? So, this thing does not capture?
44:24	PM	PF	Beep Die optimeter se back light werk ook nie, of sy nie op gedraai nie? The optimeter backlight is also not working or is it not turned on Al drie joune nie All three of yours Check nou net Check just now
44:39	PF	PM	Voken af off
44:46	PF	PM	Alles is aan Everything is on
44:50	PM	PF	So jou back light werk ook nie So your backlight is also not working
44:51	PF	PM	Ja Yes
44:56	CTN	SFV	SFV Cape Town
44:58	SFV	CTN	Go-ahead
45:01	CTN	SFV	SFV confirm ops normal
45:04	SFV	CTN	Affirm ma'am
45:05	CTN	SFV	Copied just saw on the radar that you were descending
45:11	SFV	CTN	Negative ma'am we are catching up
45:28	PF	PM	Hoekom bly hy nie voken stil?

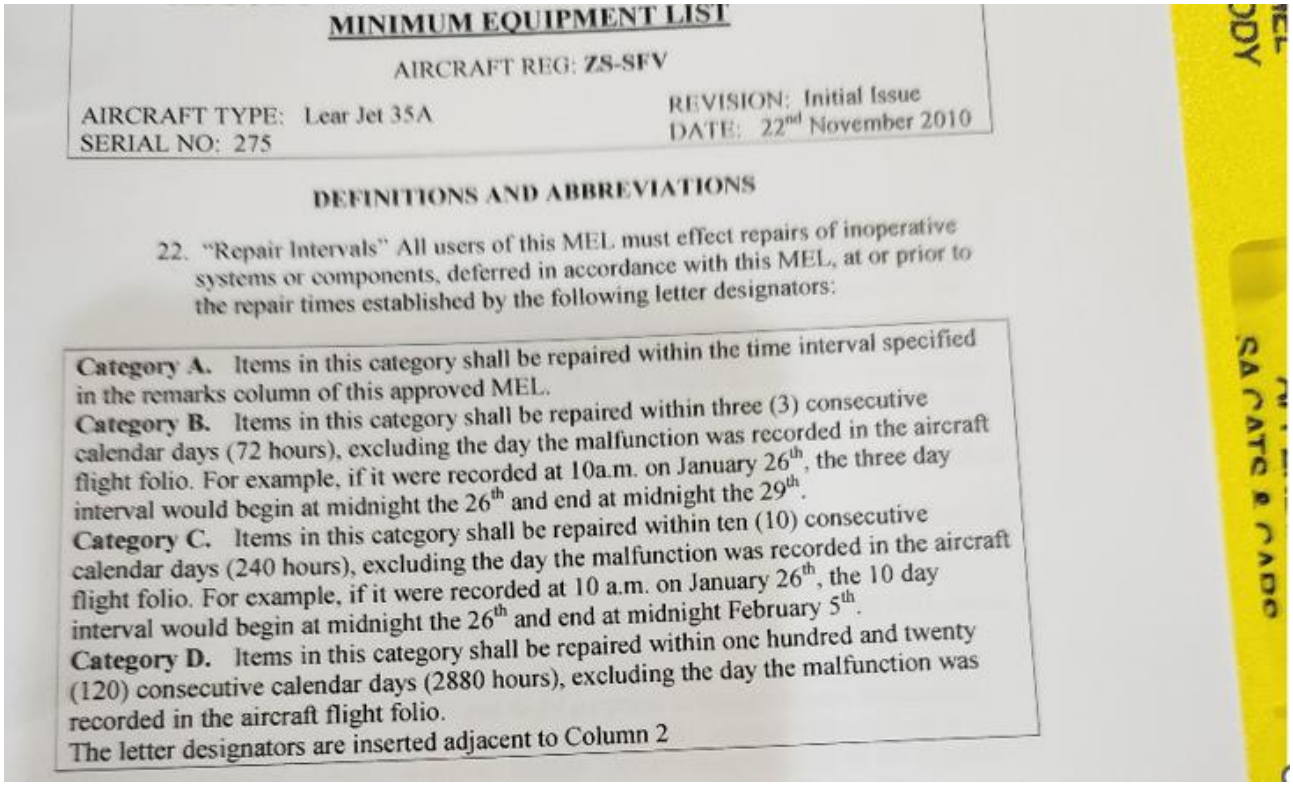
			Why doesn't he just keep quiet?
45:38	PM	PF	Wil jy nou kyk wat se sy? Do you want check what does it say now?
45:39	PF	PM	Ok ons gaan alles nav ne? Okay we are going to nave everything ne? Wat dink jy? What do you think?
45:45	PM	PF	Ja Yes
45:49	PM	PF	41 42 okay
59:22	PF	PM	So nou nou wat is ons spoed op die grond meter? So, what is out speed on the ground meter?
59:24	PM	PF	Point 78-point 77
59:27	PF	PM	Ok ek gaan nou trug kom Ok I will reduce it now
59:31	PM	PF	Ok waar gaan ons begin Ok where are we going to start
1:00:45	PM	PF	Left hand ammeter
1:00:50	PF	PM	Ja maar hy gaan die left generator… Yes, but it is going to …. the left generator
1:00:51	PM	PF	Ja nee die back light werk nie Yes, the backlight doesn't work
1:00:54	PF	PM	Ooo okay
1:01:07	PM	PF	Okay ja Okay yes
1:01:08	PF	PM	Kan nie engage nie light intermittent It can't engage the light is intermittent

1:03:54	PM	PF	Aaa left gen? Aaa left generator
1:03:56	PF	PM	Ja Yes
1:03:59	PM	PF	Left stall
1:04:04	PF	PM	Is dit left? Is it left?
1:04:05	PM	PF	Ja Yes
1:05:22	PF	PM	Hou dit aan nommer Does it keep it on the number? Check net wat was die laste nommer Just check what was the last number
1:05:31	PM	PF	Ek het nie nommers nie 1 2 3 4 5 6 7 8 9 I don't have the numbers 1 2 3 4 5 6 7 8 9
1:05:42	PF	PM	Is hy nou op nommer 3? Is it now on number 3?
1:06:41	PM	PF	Wat nog? What else? Right hand flight director
1:07:01	PF	PM	Ek het hom net 'n bietjie afsit I switched it off a little bit Ek gaan hierdie af sit bra 'n beitjie af bra I am going to switch it off bra and a little off bro
1:07:22	PM	PF	UPS
1:07:31	PF	PM	OK hy vang iets daar? Okay does it catch something there?
1:07:36	PM	PF	As jy af trim dan hy blood rooi raak If you trim down it becomes red
1:07:57	PF	PM	Seker? Sure?
1:07:58	PM	PF	Ja Yes
1:08:08	PM	PF	Daai pane is net blou Those pans are blue
1:08:13	PF	PM	Thrust reverse
1:08:52	PM	PF	Rudder trim one dot left

1:09:07	ACC CEN	SFV	SFV confirm on track to position EGPOP at this time
1:09:10	SFV	ACC CEN	Affirm Sir
1:09:13	PM	PF	Direct dalk check as jou… Direct maybe check if your…
1:09:14	PF	PM	EGPOP?
1:09:20	PM	PF	Ja Yes
1:09:37	PM	PF	Werk daar niks Nothing works
1:09:45	PF	PM	Ja gaan ek EGPOP toe? Yes am I going to EGPOP?
1:09:56	PM	PF	Ses grade link aan Six drees left
1:09:59	PF	PM	Maar ek het op 71 But I was on 71 Ooo jy vat die verskil daar ne? Oh yes you take the difference ne?
1:10:05	PM	PF	Ja kyk daai is jou direct track daai is jou actual track Yes look that is your direct track and that is your actual track
1:10:14	PF	PM	Hoekom sit jy 66? Why do you put 66?
1:10:17	PM	PF	Jou heading is ja well Your heading is… yes well
1:10:41	PM	PF	Rudder trim one stripe left
1:10:48	PM	PF	Okay wat nog? Okay what else
1:11:03	PM	PF	Ek gaan check of dit al is I will check if that's all
1:11:07	PM	PF	Hydraulic pressure light US Augmentation failure capsule Left gen fail Left stall Auto Pilot Nav Left hand backlight Left hand altimeter backlight US Left hand ammeter backlight US Emergency airspeed indicator light US Temperature gauge US on auto mode Temp gauge light US Hierso moet on se cabin tech Here we must say cabin tech Right hand flight director mode indication US Radar point left no Thrust reverse did not deploy on initial landing roll

1:12:23	PF	PM	Master
1:12:39	PM	PF	Master warning Nav and so
1:13:03	PM	PF	Wat nog? What else?
1:13:19	PF	PM	Ek kan nie dink aan nog iets nou I cant think of anything else now
1:13:20	PM	PF	Nothing for now Ons sal maar in Lanseria in gou check of die ILS werk We will check if the ILS in Lanseria works
1:13:36	PF	PM	Ja ja voor dat om ons weg pos Yes, yes before we post around us
1:13:38	PM	PF	Okay
12:02	SFV	FALA	Thank you cleared to land SFV
12:04	PM	PF	Ok ek het vir jou all die ligte aan gesit daar *Okay I have switched on all the lights for you*
12:06	PF	PM	Hoe veel feet is ons? *How may feet are we?*
12:10	PM	PF	Aaa 400 jys amper op die red 130 *Aaa 400 you are almost on the red 130*
12:13	PF	PM	Daarsy *There you go*
12:16	PM	PF	Little left of center line, mooi daai , dit was mooi daai *Nice, nice that is nice*
12:22	PF	PM	Damper uit haal, is hy uit? *Take out the streamer is it out?*
12:27	PM	PF	Aaa hys uit ja *Aaa its out yes*
12:29	PF	PM	Daarsy. Ons pull hom op die duisand *There you go. We pull it on the thousand*
12:31	PM	PF	Ok hy is amper op die red hou hom maar net daar kom af Ok maak toe Jys bietie hoog bra jys baie hoog check vooren toe *Okay it is almost on the red keep it there descend* *Okay close* *You are a little bit high bra you are very high check forward*
12:45			Soft bang
12:47			Continuous beep for the landing gear not extended
12:48	PM	PF	Ooo VOK SHIT Nee ou Ooo fucken shit No man
12:51	PF	PM	Wille. Jere ou ek het die wille vergeet Wheels. Lord, I forgot the wheels man
13:02	SFV	FALA	SFV, I need assistance
13:14	PM	PF	Fuck. Shut down shut down
13:19	PF	PM	Ok alles af. Ek het alles af sit *Okay everything off. I have everything off*

Annexure G



MINIMUM EQUIPMENT LIST

AIRCRAFT REG: **ZS-SFV**

AIRCRAFT TYPE: Lear Jet 35A
SERIAL NO: 275

REVISION: Initial Issue
DATE: 22nd November 2010

DEFINITIONS AND ABBREVIATIONS

22. "Repair Intervals" All users of this MEL must effect repairs of inoperative systems or components, deferred in accordance with this MEL, at or prior to the repair times established by the following letter designators:

Category A. Items in this category shall be repaired within the time interval specified in the remarks column of this approved MEL.
Category B. Items in this category shall be repaired within three (3) consecutive calendar days (72 hours), excluding the day the malfunction was recorded in the aircraft flight folio. For example, if it were recorded at 10a.m. on January 26th, the three day interval would begin at midnight the 26th and end at midnight the 29th.
Category C. Items in this category shall be repaired within ten (10) consecutive calendar days (240 hours), excluding the day the malfunction was recorded in the aircraft flight folio. For example, if it were recorded at 10 a.m. on January 26th, the 10 day interval would begin at midnight the 26th and end at midnight February 5th.
Category D. Items in this category shall be repaired within one hundred and twenty (120) consecutive calendar days (2880 hours), excluding the day the malfunction was recorded in the aircraft flight folio.
The letter designators are inserted adjacent to Column 2

ABSOLUTE FLIGHT SERVICES (PTY) LTD

AIRCRAFT REG: ZS-SFV	SERIAL No: 275	AIRCRAFT TYPE: Lear Jet 35A
FAA MMEL REV: 6a DATE: 15/01/2008	MEL REV: Initial DATE: 22/11/2010	MEL PAGE NO: 22-1

1. SYSTEM SEQUENCE & NUMBERS	REPAIR CATEGORY	2. NUMBER INSTALLED	3. NUMBER REQUIRED FOR DISPATCH	4. REMARKS AND EXCEPTIONS
22 AUTOPILOT				
1. Autopilot Systems				
1) Aircraft With One Autopilot Installed	B	1	0	(M)(O) May be inoperative provided: a) Maintenance procedures secure or deactivate Autopilot to ensure no interference with Flight Controls, b) Autopilot Disconnect Switch (Control Wheel Master Switch) is operative, c) Approach minimums or operations procedures do not require use of Autopilot, d) Automatic Cabin Pressurization System is operative and e) Aircraft is operated in accordance with AFM Limitations. NOTE 1: Autopilot Disconnect Switch (Control Wheel Master Switch) is required for functions other than Autopilot. **NOTE 2: For RVSM operations the Altitude Hold function must be operative.**
2) Aircraft With Two Or More Autopilots Installed				Not Applicable.

ABSOLUTE FLIGHT SERVICES (PTY) LTD

AIRCRAFT REG: ZS-SFV	SERIAL No: 275	AIRCRAFT TYPE: Lear Jet 35A
FAA MMEL REV: 6a DATE: 15/01/2008	MEL REV: Initial DATE: 22/11/2010	MEL PAGE NO: 27-2

1. SYSTEM SEQUENCE & NUMBERS	REPAIR CATEGORY	2. NUMBER INSTALLED	3. NUMBER REQUIRED FOR DISPATCH	4. REMARKS AND EXCEPTIONS
27 FLIGHT CONTROLS				
5. Flap Preselect System (35 Series With MK-II Mod., STC No. SA225NW) (35 Series With XR Mod., STC No. SA766NW) (35 Series With Flap Control Bypass System SB 35/36-27-31)	B	1	0	May be inoperative provided aircraft is operated in accordance with AFM Supplement. NOTE: Refer to AFM Supplement for procedure and reduce Flap Limit Speeds when operating in Alternate Flap Select Mode.
6. Stick Puller System				DELETED, REVISION 2.
7. Spoileron System (55 Series)				Not Applicable.

ABSOLUTE FLIGHT SERVICES (PTY) LTD

AIRCRAFT REG: ZS-SFV	SERIAL No: 275	AIRCRAFT TYPE: Lear Jet 35A
FAA MMEL REV: 6a DATE: 15/01/2008	MEL REV: Initial DATE: 22/11/2010	MEL PAGE NO: 27-2

1. SYSTEM SEQUENCE & NUMBERS	REPAIR CATEGORY	2. NUMBER INSTALLED	3. NUMBER REQUIRED FOR DISPATCH	4. REMARKS AND EXCEPTIONS
27 FLIGHT CONTROLS				
5. Flap Preselect System (35 Series With MK-II Mod., STC No. SA225NW) (35 Series With XR Mod., STC No. SA766NW) (35 Series With Flap Control Bypass System SB 35/36-27-31)	B	1	0	May be inoperative provided aircraft is operated in accordance with AFM Supplement. NOTE: Refer to AFM Supplement for procedure and reduce Flap Limit Speeds when operating in Alternate Flap Select Mode.
6. Stick Puller System				DELETED, REVISION 2.
7. Spoileron System (55 Series)				Not Applicable.

ABSOLUTE FLIGHT SERVICES (PTY) LTD

AIRCRAFT REG: ZS-SFV	SERIAL No: 275	AIRCRAFT TYPE: Lear Jet 35A
FAA MMEL REV: 6a DATE: 15/01/2008	MEL REV: Initial DATE: 22/11/2010	MEL PAGE NO: 34-1

1. SYSTEM SEQUENCE & NUMBERS	REPAIR CATEGORY	2. NUMBER INSTALLED	3. NUMBER REQUIRED FOR DISPATCH	4. REMARKS AND EXCEPTIONS
34 NAVIGATION				
1. Standby Attitude Indicator	C	1	0	May be inoperative provided not required by CAR 121.05.3 **[See Appendix Q]**
	B	1	0	May be inoperative provided: a) Operations are conducted in Day VMC only, and b) Operations are not conducted into known or forecast over-the-top conditions.
2. Radio Magnetic Indicator (RMI) Systems				
1) (Aircraft Not Equipped With EFIS)	C	2	1	I.A.W. CAR 91.05.2 **[See Appendix A]** Ref. SA-CATS.OPS 91.05.1(5) **[See Appendix K]**
3. Distance Measuring Equipment (DME) Systems	D	2	1	I.A.W. CAR 91.05.2 **[See Appendix A]** Ref. SA-CATS.OPS 91.05.1(5) **[See Appendix K]**
4. Weather Radar Systems				
1) Weather Display	C	1	0	I.A.W. CAR 121.05.6 **[See Appendix F]** (O) May be inoperative.
2) Navigation Display		0	0	Equipment not installed.
3) Checklist Display		0	0	Equipment not installed.
5. Weather Storm Scopes		0	0	Equipment not installed.
6. Automatic Direction Finding (ADF) Systems	C	2	1	I.A.W. CAR 91.05.2 **[See Appendix A]** Ref. SA CATS OPS 91.05.1(5) **[See Appendix K]**