

AIRCRAFT ACCIDENT INVESTIGATION REPORT

INVESTIGATION REPORT ON AN ACCIDENT INVOLVING MAULE 5-210C AIRCRAFT REGISTERED ZS – JIP THAT OCCURRED ON THE 28th MAY 2023 AT LIMPOPO VALLEY AIRFIELD – MASHATU, BOTSWANA.



REFERENCE MTPW/AIG 12/23

Name of Owner	OE Bearings (Pty) Ltd
Aircraft make and Registration	Maule 5-210C Registration ZS - JIP
Occurrence date	28 th May 2023
Investigation Authority	Directorate of Accident Investigation (Ministry of Transport and Public Works) – Republic of Botswana

Purpose of the investigation

This investigation was conducted in accordance with Botswana Civil Aviation (Accident and Incident Investigation) Regulations of 2022, that is in line with ICAO Annex 13 for the principal purpose of determining the circumstances and causes of the accident with a view to the preservation of life and avoidance of similar accidents in future and not to ascribe blame to any persons.

The **Civil Aviation Act of 2011 at Section 75** as amended stipulates that:

The sole objective of the investigation of an accident or incident shall be the prevention of accidents and incidents and not to apportion liability or blame.

Disclaimer:

This report is circulated without prejudice to the rights of the investigating authority, which are reserved.

DAI categorized this occurrence as an accident that warranted a full investigation. An Investigator-in-Charge (IIC) was appointed to conduct the investigation. DAI allocated the investigation a file reference number MTPW/AIG/12/23.

The State of Registry was notified and it has assigned an Accredited Representative (ACCREP).

Finally, in the event that any party comes across any new information/evidence that might have a bearing on the accident, they must share it with the IIC at jsebineng@gov.bw or contact (267) 73005766.

Directorate of Accident Investigation

Private Bag 007

Gaborone

Botswana

In accordance with regulation 36 (1)(b)(i) of the Civil Aviation (Accident and Incident Investigation) Regulations of 2022, a copy of the draft final report was served to both persons and entities of interest. Their significant and substantiated feedback was received and forms an Annexure to this report.

Note that the comments from the PIC have been adopted to amend the report whereas the comments from Accredited Representative (ACCREP) have been noted but not adopted to amend the report.

For full appreciation of the feedback comments refer to Annexure 1. Adopted comments onto the report are denoted by underlined and italic sentences at the Synopsis and paragraph 1.12.2.

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Glossary of Abbreviations

ATC:	Air Traffic Control
CAAB:	Civil Aviation Authority of Botswana
CoA:	Certificate of Airworthiness
CoR:	Certificate of Registration
CRS:	Certificate of Release to Service
ELT:	Emergency Locator Transmitter
FBLV:	Limpopo Valley Airfield
MED:	Medical
MSB:	Mandatory Service Bulletin
PIC:	Pilot in Command
PPL:	Private Pilot License
RSA:	Republic of South Africa
RWY:	Runway
SACAA:	South African Civil Aviation Authority
SB:	Service Bulletin
TCM:	Teledyne Continental Motors
UTC:	Universal Time Coordinate
ZA:	Republic of South Africa

Synopsis

On the 28th May 2023 at 0906 UTC, ZS – JIP took off from FBLV airfield destined to Polokwane in the Republic of South Africa. ZS – JIP is a Maule 5-210C tail dragger aircraft owned by OE Bearings (Pty) Ltd of South Africa. The aircraft had two (2) crewmembers with no passengers onboard. It had fuel endurance of three (3) hours at the time of departure.

Shortly after take-off using runway 12 at FBLV airfield, the aircraft experienced a rough running engine. The traffic that was nearby alerted the ATC of the ZS – JIP decision to return and land the aircraft.

The aircraft was still in the climb phase of the flight and it was at an altitude of approximately five hundred (500) feet (approx.150meters) when a turnaround was initiated to bring it to land. The weather conditions were clear skies with a wind speed of about five (5) knots.

Due to a sudden stoppage of the engine during the final leg of the circuit, ZS – JIP fell short of the runway. It crashed at approximately three hundred (300m) meters from the runway threshold, outside of the airfield perimeter fence. The continued loss of altitude on the final leg led to collision with obstacles in the form of small trees and shrubs along the flight path.

ZS – JIP wings and underbelly were impact points during the collision with the vegetation. Inside the wings structure are the main fuel tanks and the auxiliary tanks which are placed on the inboard side and the outboard side respectively. Fuel supply cross feed lines are routed under the crew seats and under on this particular Maule 5-210C aircraft, the battery is located under the right-side crew seat. This arrangement rendered the aircraft underbelly susceptible to fire in the event of a crash.

The impact force led to rupture of fuel lines supplying fuel to the engine and the impact produced spark that ignited the leaked fuel. According to the crew the fire started underneath around their legs at the foot pedals zone. It proceeded from the firewall to consume the rest of the fuselage. The aircraft nose and the wings were the only components spared of the flame.

The crew suffered varying degrees of burns from the fire. They were admitted for treatment at a medical hospital in Polokwane (RSA). The airfield

emergency services responded timeously to the accident and managed to save the lives of people as well as contain the fire blaze as it did not spread beyond the aircraft wreckage.

The aircraft came down due to loss of engine power which was caused by failure of *both magnetos*. A magneto impulse coupling failed and caused engine stoppage. The accident could have been avoided had the aircraft managed to make it back onto the runway.

A safety recommendation is made to require full compliance with the mandatory service bulletin by Teledyne Continental Motors on inspection of riveted impulse coupling and stop pins by users of magnetos using the described impulse coupling.

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1. FACTUAL INFORMATION

1.1 HISTORY OF FLIGHT

1.1.1 ZS – JIP took-off from Limpopo Valley airfield at 0906 UTC on the 28th May 2023 enroute to Polokwane in the Republic of South Africa on a private flight.

1.1.2 Shortly after take-off and in the process of climbing at approximately 500feet (150meters), the aircraft experienced a rough running engine. The PIC took a decision to turn the aircraft around in order to land it safely on runway 12 of Limpopo Valley airfield.

1.1.3 The weather conditions were clear skies with no clouds and the wind speed on the day was 5 knots and a moderate temperature of 24°C.

1.2 INJURIES TO PERSONS

Injuries	Crew	Passengers	Others
Fatal	00	00	00
Serious	02	00	00
Minor/None	00	00	

1.3 DAMAGE TO AIRCRAFT

1.3.1 The aircraft was substantially damaged by the post impact fire save for the aircraft nose and the wings.

1.4 OTHER DAMAGE

1.4.1 There was little damage done to the surroundings as the emergency team managed to contain the resultant post impact fire.

1.5 PERSONAL INFORMATION

Nationality	South African	Gender	Male	Age	63
License #	0272441247	Date of Issue	03/05/2021 until 31/05/2023	Endorsement	PPL (A)
Ratings	PIC: C172; M5: J3; SLG4; Echo	A/C type	Cessna 172; Skyhawk. Cutlass, Hawk XP, Reims Rocket; Maule M – 5, Piper J3 Cub; Tecnam P92; Sling 4	English Proficiency	6
Medical	SACAA Class 2/4 (ZA.MED.738 27)	Limitations	Correction for defective distant vision	Previous Accident	nil
Total flying time	experienced	Total flying on tyoe	experienced		

1.6 AIRCRAFT INFORMATION

1.6.1 ZS – JIP is a tail dragger that had a valid certificate of airworthiness issued by the SACAA.

1.6.2 The aircraft was issued with a certificate of release to service on the 24th March 2023 following annual maintenance by the approved maintenance organization. The CRS certifies that the aircraft and all its components are serviceable for flight and that all maintenance has been carried out in accordance with the civil aviation regulations, as amended, and the aircraft accepted/approved maintenance schedule.

Manufacturer & model	Maule Aircraft Corporation & Maule M5-210C	Serial Number:	6154 C	Year of Manufacturer	1975
Date of Registration	15/05/2013	CoR #	230/ZS – JIP/1	Category	Standard normal airplane
Aircraft Total time	2291.17 (+/- 30) Hours	CRS date of issue	23/03/2023	Time elapsed since CRS	+/- 30hours
Engine Constructor	Continental	Engine Type	IO – 360 – D	Constructor #	351279
Engine Construction date	10/11/1976	Engine total time since new	2291.17 hrs. (+/- 30) Hours	Engine total time since overhaul	1124.17 hrs.
Propeller Constructor	McCauley	Propeller Type	Constant speed model	Propeller Number/Serial	D2A34C67/807961
Prop blades #	2	Prop total time	n/a	Prop total time since overhaul	447.17 hrs.
ELT make & model	Kannad 406	Emission class & Frequency	121.5/406 MHz	Radio License #	537-670-3

1.7 METEOROLOGICAL INFORMATION

1.7.1 The weather conditions did not have any bearing on the accident

1.8 AIDS TO NAVIGATION

1.8.1 The aids to navigation did not have any bearing on the accident.

1.9 COMMUNICATIONS

1.9.1 Communications did not have any bearing on the accident.

1.10 AERODROME INFORMATION

- 1.10.1 Limpopo Valley airfield is CAAB approved. It is located in eastern side of Botswana at coordinates 22° 11 ' 21" S and 29° 07 ' 37" E. It has a tarred runway of 1500meters at elevation of 1770 feet (539meters) above sea level.

1.11 FLIGHT RECORDERS

- 1.11.1 Flight recorders did not have a bearing on the accident.

1.12 WRECKAGE AND IMPACT INFORMATION

- 1.12.1 The aircraft wreckage was intact with only a left-wing tip bent due to collision with tree branches which caused substantial damage.

- 1.12.2 The left auxiliary fuel tank fell off the wing structure onto the ground next to aircraft *due to complete burn-out* of the material comprising the wing.

- 1.12.3 The wreckage was consumed by post impact fire save for the right-hand side wing and the aircraft nose that consists of the engine and the propeller.

1.13 MEDICAL AND PATHOLOGICAL INFORMATION

- 1.13.1 Both persons onboard the aircraft sustained severe burns and were air lifted to RSA for medical assistance.

- 1.13.2 There were no fatalities as a result of the accident.

1.14 FIRE

- 1.14.1 Post impact fire resulted due to the aircraft crashing onto the trees with its underbelly and the wings.

- 1.14.2 As a result of the impact the fuel supply lines were broken causing fuel to leak.
- 1.14.3 The impact on the aircraft underbelly also affected the battery which was located underneath the crew seat, resulting in fire starting from below the seats around the proximity of the pedals.
- 1.14.4 The firefighting equipment used managed to contain the fire.

1.15 SURVIVAL ASPECTS

- 1.15.2 The accident was survivable and the severity of the injuries could have been less. The routing of the fuel lines and the location of the battery under the crew seat increased the chances of fire developing at the foot pedals.
- 1.15.3 The crew endured injuries from the feet going up their upper bodies as the flame flared.
- 1.15.4 The right-hand side door was blocked from opening by the right-hand wing which had bent slight to prevent the door open movement.
- 1.15.5 The above scenario led to the crew member on the right-hand side sustaining more injuries as he stayed longer in the cabin in an effort to move across and use the only operational door to escape on the left-hand side.
- 1.15.6 The fire was also intense on the left-hand side as the left main tank exploded due to excessive heat.

1.16 TESTS AND RESEARCH

- 1.16.1 The engine was taken in for an observed stripping and analysis. Since it was intact and showing no external signs of damage, the inclination was to run it on the bench using a different propeller. This was not successful as both magnetos did produce a spark.

- 1.16.2 The right-hand side magneto did not turn completely.
- 1.16.3 After disassembly of the magnetos it was found that the drive cushion on the left magneto was deformed completely. (see **figure 1**)
- 1.16.4 Also, the left magneto gear retainer assembly was damaged by way of shearing at the corners and it was completely deformed. (see **figure 2, 2a**)
- 1.16.5 The sleeve of the left magneto drive gear had big chunks of metal pieces broken off in more than one place. (see **figure 3 & 4**)
- 1.16.6 The right-hand side magneto distributor gear was found with broken gear teeth. (See **figure 5**)
- 1.16.7 The alternator was discovered to have a lot of play and its drive shaft was slightly bent.
- 1.16.8 The alternator gear teeth showed some cracks due to an intruding object in the gear mechanism.
- 1.16.9 The left magneto impulse coupling flyweight was found broken into two (2) pieces. (see **figure 6**)

1.17 ORGANISATIONAL AND MANAGEMENT INFORMATION

- 1.17.1 This had no bearing on this accident.

1.18 ADDITIONAL INFORMATION

- 1.18.1 Not applicable.

2. ANALYSIS

- 2.1** The left magneto ceased in operation leading to the magneto drive sleeve pieces breaking off. The sudden stoppage of the magneto was caused by an impulse coupling flyweight that broke into two pieces inside the magneto.
- 2.2** The pieces of a broken magneto drive sleeve fell off and got trapped between the alternator gear drive leading to cracks on the alternator gear teeth as well as bending the alternator shaft.
- 2.3** The right magneto ended up with broken distributor gear probably due to the fact it was still in operation when there was a sudden stoppage of the engine.

CONCLUSIONS

- 2.4** Failure of the left magneto impulse coupling flyweight resulted in its splitting into two pieces at the pivot axle led the magneto to cease.
- 2.5** The sudden stoppage caused failure of the magneto drive gear sleeve linked to crankshaft gear as the torque on the crankshaft gear was far too excessive. The magneto drive gear sleeve broke in more than one place.
- 2.6** The broken pieces of a drive gear sleeve fell in between the gears linking the alternator with the engine. Alternator drive gear teeth exhibited signs of minor cracks (chipped edges) due to the presence of foreign metal pieces that interfered with the crankshaft/alternator gear motion. The alternator drive shaft ended up bent due to interference by the metal piece.
- 2.7** ZS – JIP lost the power sources as the left magneto and the alternator failed in operation.

2.8 The scenario above led to failure of the right magneto. The interference of a drive sleeve metal piece caused the engine to abruptly stop running and this adversely affected the right magneto. As a result of sudden stoppage, the right magneto which was functioning properly broke a considerable number of distributor gear teeth that were linked to the crankshaft. This left the aircraft engine with no power source at all.

CONTRIBUTING FACTORS

2.9 As the aircraft failed on its attempt to turn back to land on the runway, it landed outside the airfield parameter fence thereby colliding with the trees and shrubs on its path. These caused the breakage of the left-wing tip and the left auxiliary fuel tank fell onto the ground.

2.10 The fuel cross-feed lines passing underneath the crew seat were also affected by the crash impact on the aircraft underbelly as the collision resulted in damaged fuel lines and fuel leakage. (**see figure 7, 7a**)

2.11 The location of the battery under the crew seat contributed to the fire that broke out from that area since the battery was a source of spark to the fuel from broken and leaking fuel lines.

3. SAFETY RECOMMENDATIONS

3.1 A safety recommendation is thus made which requires immediate compliance with the mandatory service bulletin by Teledyne Continental Motors on inspection of riveted impulse coupling and stop pins by users of magnetos using the Bendix magnetos that use riveted impulse coupling flyweights.

3.2 It is recommended that positioning of a battery under the crew seat be revised as it could pose risk to the crew at crucial times of aircraft operation.

3.3 It is recommended that Limpopo valley airfield fire-fighting team conduct emergency fire drills at regular intervals in order to improve on their response time and ascertain their hardware readiness.

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APPENDICES



Figure 1: Damaged magneto retainer bushing



Figure 2: Damaged magneto retainer (top view)



Figure 3: Magneto drive sleeve with a big metal chunk broken off.



Figure 4: Top view of the left magneto drive sleeve broken in two places.

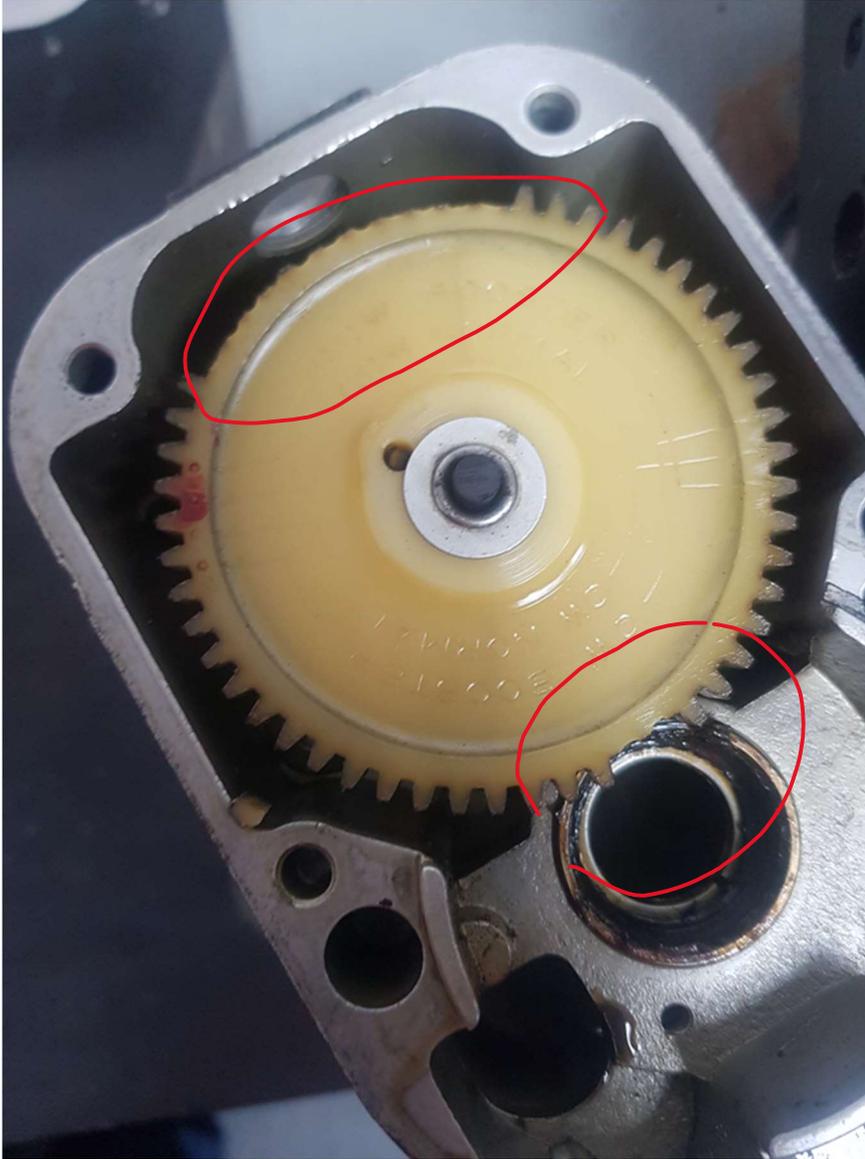


Figure 5: Right hand magneto distributor with broken gear teeth at the top and bottom



Figure 6: Left magneto impulse coupling flyweight broken into 2 pieces at the axle

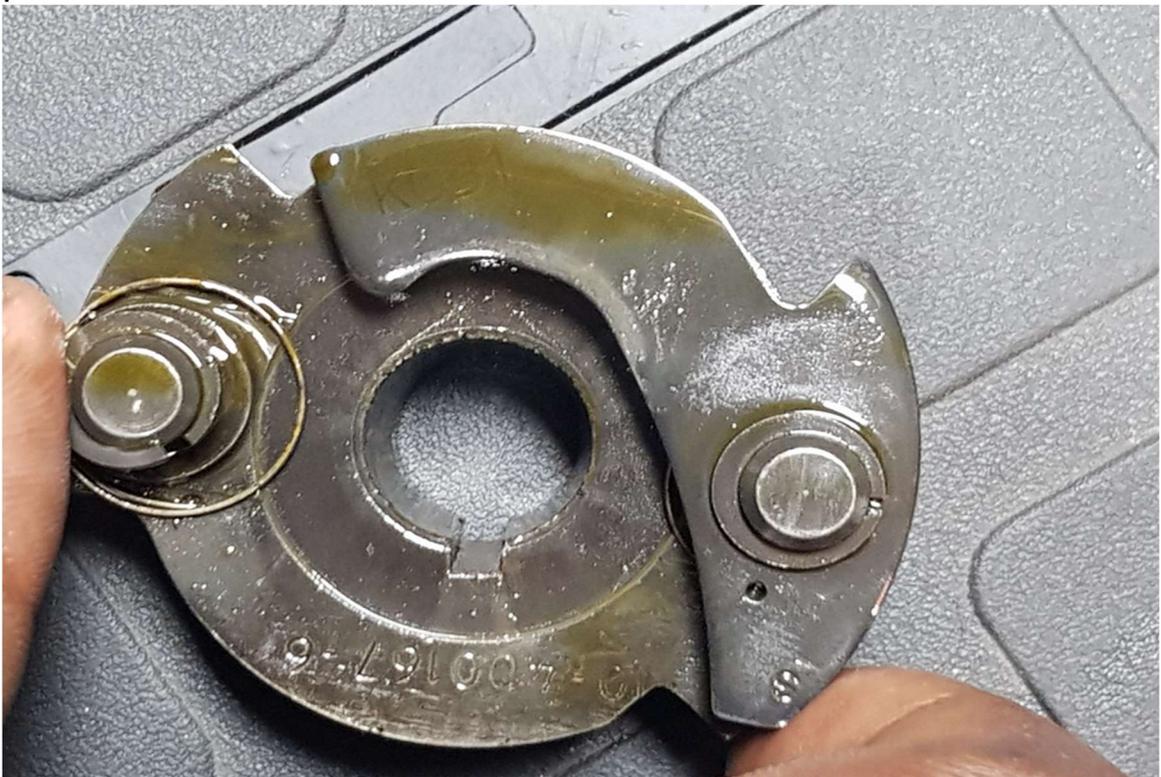


Figure 6a: Left hand magneto impulse coupling missing a flyweight which broke into two pieces.



Figure 7: A pre – accident pictorial showing the battery location under the crew seat.

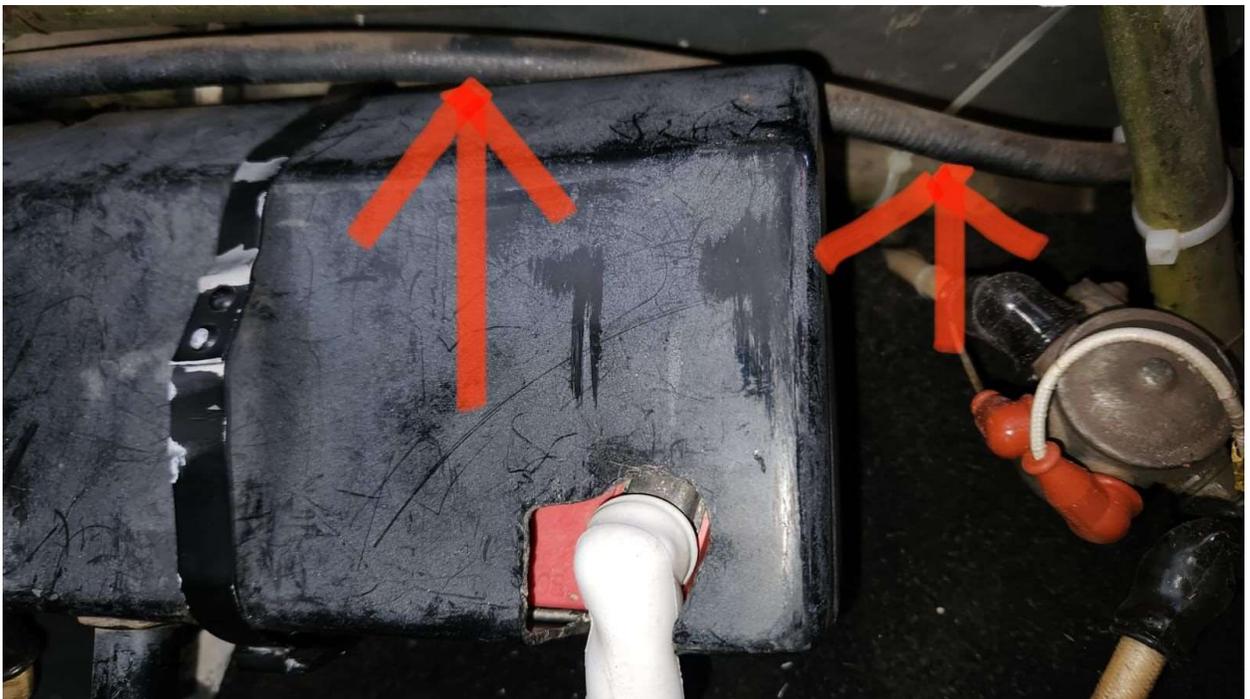


Figure 7a: Illustration showing a fuel line passing above the battery housing



Figure 8: Left wing with the auxiliary wing tank fallen off due to fire



Figure 8a: Fallen off left auxiliary fuel tank.



Figure 8b: Illustration of a left main fuel tank that exploded due to post impact fire.



Figure 9: Illustration depicting that the engine was not affected by the post impact fire.



Figure 10: The view of the cockpit post impact fire which was concentrated aft of the firewall.



Figure 11: The aircraft nose survived the fire blaze.



Figure 11a: Front view of the wreckage



Figure 11b: The side view remnant aircraft wreckage post impact fire.

-END-

ANNEXURE 1

COMMENTS FROM STAKEHOLDERS

COMMENTS SUBMITTED BY THE PILOT IN COMMAND DURING THE DRAFT FINAL REPORT REVIEW.

Sent: Wednesday, December

To: Joseph Ebineng <jsebineng@gov.bw>

Cc: lva@mashatu.com

Subject: RE: Documents relating to draft report circulation

Hi Joseph

Thanks for the email, as mentioned I was away hence the delayed response. There are some minor changes I would suggest as follows:

Page 6 Paragraph 2	I did not contact ATC but rather the traffic in the area to announce my intention to return to the airfield.
Page 6 Paragraph 4	On short finals the engine stopped dead, not lack of power no power.
Page 7 Paragraph 2	Both magnetos failed, not one.
Page 11 1.12.1	The left Auxiliary fuel tank fell onto the ground once the wing material burned.
Page 14 3.4 Alternator failure.	ZS-JIP lost all power due to both Magneto failure. I am not sure there was
Page 16 4.3	Totally support this recommendation.

Once the above changes I believe the report is an accurate reflection on the sequence of events and the cause of the crash of ZS-JIP.

Please feel free to call me to discuss any of the above.

Regards
Warwick.

COMMENTS SUBMITTED BY THE ACCREDITED REPRESENTATIVE OF THE STATE OF REGISTRY DURING THE REVIEW OF THE DRAFT FINAL REPORT

From: <@caa.co.za>

Sent: Monday, 04 December 2023

To: Joseph Ebineng <jsebineng@gov.bw>

Subject: RE: ZS JIP Draft Final Report

Good afternoon Mr Ebineng,

I take note of the below statement on the draft report which is according to my understanding of the aircraft, inappropriate. The impact on the aircraft underbelly also affected the battery which was located underneath the crew seat, resulting in fire starting from below the seats around the proximity of the pedals. The aircraft battery is at the tail, empennage area, therefore the above statement is erroneous. Arching electrical wires behind the fire wall seemed to have caused the fire.

Regards,