AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

			Reference:			**CA18/2/3/9942**	
Aircraft Registration	**ZS-JJJ**	**Date of Accident**	13 January 2021			**Time of Accident**	0515Z
Type of Aircraft	Piper PA-46-350P Jetprop DLX		**Type of Operation**			Private (Part 91)	
Pilot-in-command Licence Type	Private Pilot Licence (PPL)		**Age**	69		**Licence Valid**	Yes
Pilot-in-command Flying Experience	**Total Flying Hours**		6 654.0			**Hours on Type**	772.2
Last Point of Departure	Koedoesberg Game Farm private airstrip, KwaZulu-Natal Province						
Next Point of Intended Landing	Pongola Aerodrome (FAPL), KwaZulu-Natal Province						
Damage to Aircraft	Substantial						
Location of the accident site with reference to easily defined geographical points (GPS readings if possible)							
On a gravel road 500m from the take-off runway; Global Positioning System co-ordinates: 27°26'34.69'' South 031°41'2.91'' East) at an elevation 913 feet (ft)							
Meteorological Information	Surface wind: 095°/3kts, temperature: 25°C, dew point: 22°C, Visibility: CAVOK,						
Number of People On-board	1 + 0	**Number of People Injured**	1	**Number of People Killed**	0	**Other (On Ground)**	0
Synopsis							

On Wednesday, 13 January 2021, a pilot on-board a Piper PA-46-350P Jetprop DLX aircraft with registration ZS-JJJ took off from Koedoesberg Game Farm private airstrip. The intention of the flight was to practise instrument flight approach and landing at Pongola Aerodrome (FAPL) using non-directional beacon (NDB) Papa-Golf-Lima (PGL) in preparation for the pilot's licence renewal. The flight was conducted under the provisions of Part 91 of the Civil Aviation Regulations (CAR) 2011 as amended. The pilot reported that shortly after take-off, he experienced an engine power loss and elected to execute a forced landing on a gravel road 500 metres (m) from the threshold of Runway 11. The aircraft touched down hard and the undercarriage collapsed before the aircraft veered off to the right-side of the gravel road. The propeller blades struck the ground and broke off during the forced landing. The aircraft came to a stop on its fuselage (belly). The pilot sustained serious injuries during the accident and was admitted to hospital. Examination of the engine displayed two loose B-nuts at the P3 air-filter housing. A leak test revealed that there was an air leak at the B-nuts, which could have led to a reduction in engine power during take-off.

Probable Cause

Engine power loss in-flight, resulting in an unsuccessful forced landing.

Contributing Factor/s:

Disregard for standard safe operating procedures by the pilot/owner of the aircraft. The engine investigation revealed that there was an air leak at the B-nuts that attach to the P3 air-filter housing which supplies air to the fuel control unit. The air leak could have contributed to the reduction in engine power during this flight.

SRP date	8 March 2022	Publication date	14 March 2022

DESCRIPTION OF THE ACCIDENT

Reference Number	**:** CA18/2/3/9942
Name of Owner	**:** Mbega Trust
Name of Operator	**:** Carel Jacobsz
Manufacturer	**:** Piper Aircraft Corporation
Model	**:** PA-46-350P Jetprop DLX
Nationality	**:** South African
Registration Marks	**:** ZS-JJJ
Place	**:** Koedoesberg Game Farm, Pongola, KwaZulu-Natal Province
Date	**:** 13 January 2021
Time	**:** 0515Z

Purpose of the Investigation:

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

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

Investigation Process:

The accident was notified to the Accident and Incident Investigations Division (AIID) on 13 January 2021 at about 0545Z. The investigator conducted an off-site investigation. The investigator co-ordinated with all authorities on the accident investigation process according to CAR Part 12 and investigation procedures. The state of manufacture/design appointed an Accredited Representative and Advisor in accordance with CAR 2011 Part 12 and ICAO Annex 13. The AIID is leading the investigation as the Republic of South Africa is the State of Occurrence.

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

- *Accident — this investigated accident*
- *Aircraft — the Piper PA-46-350P Jetprop DLX 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
ACCID	Accident
AIID	Accident and Incident Investigations Division
AME	Aircraft Maintenance Engineer
AMO	Aircraft Maintenance Organisation
AMSL	Above Mean Sea Level
°C	Degree Celsius
CAR	Civil Aviation Regulations
CAVOK	Ceiling and Visibility OK
CRS	Certificate of Release to Service
CVR	Cockpit Voice Recorder
EMM	Engine Maintenance Manual
FAPL	Pongola Aerodrome
FAWB	Wonderboom Aerodrome
FCU	Fuel Control Unit
FDR	Flight Data Recorder
ft	Feet
GPS	Global Position System
IIC	Investigator-in-charge
IOC	Investigator-on-call
Kg	Kilograms
Kt	Knot/s
m	Metre/s
MCM	Maximum Certificated Mass
METAR	Meteorological Routine Aerodrome Report
MPI	Mandatory Periodic Inspection
N/A	Not Applicable
nm	Nautical Mile
PPH	Pounds per Hour
QNH	Query Nautical Height (Altimeter sub-scale setting to obtain elevation when on ground)
RWY	Runway
SACAA	South African Civil Aviation Authority
SAWS	South African Weather Service
UTC	Co-ordinated Universal Time
VFR	Visual Flight Rules
VMC	Visual Meteorological Condition
Z	Zulu (Term for Universal Coordinated Time-Zero hours Greenwich)

1. FACTUAL INFORMATION

1.1. History of Flight

1.1.1. On 9 December 2020, the pilot on-board a Piper aircraft PA-46-350P Jetprop DLX with registration ZS-JJJ took off from Koedoesberg Game Farm private airstrip, near Pongola in KwaZulu-Natal, to Wonderboom Aerodrome (FAWB) in Gauteng province. The pilot, who was also the owner of the aircraft, reported that after take-off, the aircraft did not have enough power, however, he decided to continue with the flight to FAWB. The aircraft maintenance organisation (AMO) was informed of this defect; they proceeded to check all linkages of the fuel control unit (FCU) on request of the aircraft's owner. The aircraft was then subjected to a ground-run which was carried out with the pilot/owner of the aircraft present. The engine parameters were satisfactory. The aircraft was then towed to the owner's hangar at FAWB.

1.1.2 On 20 December 2020, the pilot took off from FAWB with the intention to return to his farm near Pongola, but shortly after take-off, the aircraft experienced loss of engine power once again. The pilot flew a circuit and landed back at FAWB; thereafter, he contacted the AMO. The pilot was advised by the AMO to park the aircraft in his hangar and to return to his farm by car (vehicle).

1.1.3 On 21 December 2020, the Accountable Manager from the AMO contacted the engine representative in South Africa and asked for assistance with the loss of engine power problem. The engine representative instructed them (AMO) to carry out the propeller governor and FCU checks as per the engine maintenance manual (EMM) 71.00.00 Chapters 9 and 10 and then to share the results with the representative. A WhatsApp message was then sent to the pilot/owner by the Accountable Manager informing him that the engine manufacturer had recommended that they carry out certain checks on the engine as per the maintenance manual requirements. He recommended that the aircraft should not be flown until the engine problem was further investigated and resolved. The next day at 17:01 (local time), the pilot/owner replied to the WhatsApp message, asking if they have found the fault. On 23 December 2020, the AMO carried out the checks as recommended by the engine representative, and no fault was found. The Accountable Manager then phoned the engine representative (based in Canada) and shared the results with him. He, in turn, recommended that the FCU be removed from the engine and be subjected to a bench test. This information was communicated to the pilot/owner via a WhatsApp message, and the aircraft was returned to the owner's hangar.

1.1.4 On 5 January 2021, the pilot/owner of the aircraft accompanied by an independent person (PT6 engine expert) whom the pilot/owner approached for a second opinion, arrived at the AMO that was maintaining the aircraft and stated that they wanted to do a 'test' flight on the

aircraft. The pilot/owner, the independent person and the Accountable Manager of the AMO all went on the (test) flight. They flew two circuits at FAWB and no reduction in engine power was noted. All engine parameters were found to be within limits.

1.1.5 On 6 January 2021, the flight folio (Page No. 32) had a recorded torque fault which was not resolved. On 8 January 2021, the pilot/owner flew the aircraft from FAWB to Koedoesberg Game Farm, this flight was not recorded in the flight folio. The pilot/owner sent the Accountable Manager of the AMO photographs of the engine parameters via WhatsApp during this flight, which indicated normal engine operations. *Figure 1 shows the aircraft in the climb phase passing 15 740 feet (ft) to 23 000ft (FL230), with six different engine parameters visible.*

Figure 1: The engine instruments indicating normal operation during the climb.

1.1.6 On 12 January 2021 at 0343Z the local engine representative sent a letter dated 11 January 2021 via email to the Accountable Manager of the AMO, which was drafted by the Customer Service Manager for Piper aircraft at Pratt and Whitney Canada (P&WC). In the letter, he stated that "*he heard that the aircraft in question had an issue with a reduction in engine power after take-off and that troubleshooting did not turn up the root cause of this event. Three contributory factors initially come to mind in this instance, (i) fuel contamination, (ii) binding/worn FCU linkages, (iii) or the FCU itself. As no fault was found, there is the potential that the same issue might happen again. An intermittent FCU is difficult to diagnose on wing. We would like to work with you to get the FCU back to P&WC for investigation*". The AMO could not convey the message to the aircraft's owner/pilot on the same day as he was out of the country.

1.1.7 On Wednesday morning, 13 January 2021, the pilot took off on a private flight from his farm, Koedoesberg Game Farm to Pongola Aerodrome (FAPL), which was 6 nautical miles (nm) north-west of his farm. The intention of the flight was to practise instrument flight approach and landing at Pongola Aerodrome (FAPL) using non-directional beacon (NDB) Papa-Golf-Lima (PGL) in preparation for the pilot's licence renewal. At this stage, the reduction in engine power after take-off was not as yet resolved. The pilot/owner was well aware of this as he was advised by the Accountable Manager of the AMO that the FCU had to be removed from the engine and sent to the manufacturer for investigation.

1.1.8 Shortly after take-off from Runway 29 at Koedoesberg Game Farm, the engine again experienced a reduction in engine power. The aircraft was unable to sustain flight and the pilot decided to execute a forced landing on a gravel road approximately 500 metres (m) from the threshold of Runway 11. The aircraft touched down hard and the undercarriage collapsed before it veered off to the right-side of the gravel road. As a result of the collapsed undercarriage, the propeller blades struck the ground and all four propeller blades were severed at their respective roots. The aircraft came to rest on its lower fuselage. According to the pilot's son, who was the first person at the scene, the engine was still running when he arrived. He then switched it off. The aircraft sustained substantial damage, and the pilot was seriously injured during the accident sequence as his face impacted the instrument panel. He was admitted to hospital where he underwent surgery.

1.1.9 The accident occurred during day light at Global Positioning System (GPS) coordinates determined to be 27°26'34.69'' South 031°41'2.91'' East, at an elevation of 913 feet (ft).

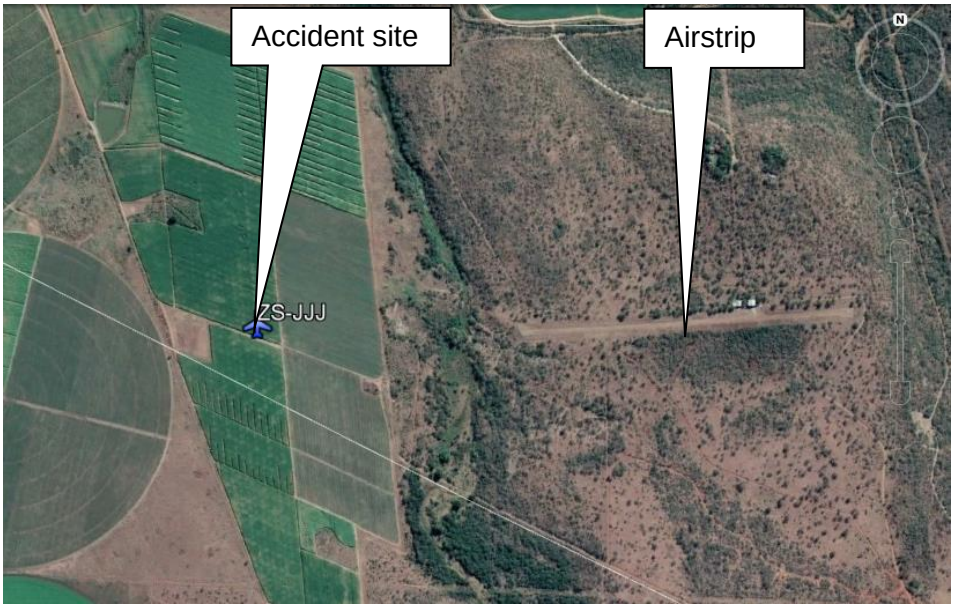

Figure 2: The approximate position of the accident site and the airstrip. (Source: Google Earth)

1.2. Injuries to Persons

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

Note: Other means people on ground.

1.3. Damage to Aircraft

1.3.1 The aircraft sustained substantial damage during the accident sequence.

Figure 3: The damaged aircraft post-accident. (Source: Owner)

1.4. Other Damage

1.4.1 A small portion of sugar cane crops were destroyed during the accident sequence.

1.5. Personnel Information

Nationality	South African	Gender	Male	Age	69
Licence Number	*********	Licence Type	Private Pilot Licence		
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	Instrument				
Medical Expiry Date	31 January 2021				
Restrictions	Must wear corrective lens				
Previous Accidents	None				

Flying Experience:

Total Hours	6 654.0
Total Past 24 Hours	0.0
Total Past 7 Days	3.0
Total Past 90 Days	20.5
Total on Type Past 90 Days	17.0
Total on Type	772.2

1.5.1 The pilot was issued a Private Pilot Licence (Aeroplane) on 21 July 1972, and his last validation flight was carried out on 20 January 2020 with an expiry date of 31 January 2021. The pilot was issued a Class 2 aviation medical certificate on 10 January 2020 with an expiry date of 31 January 2021. The pilot did the conversion to the aircraft type on 12 May 2011.

Aircraft Maintenance Engineer (AME) Experience:

Nationality	South African	Gender	Male	Age	32
Licence Type	Aircraft Maintenance Engineer				
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	P & W PT6A Series				
Restrictions	None				
Previous Accidents	None				

1.5.2 The aircraft maintenance engineer (AME) who released the aircraft to service was initially issued an AME Licence on 2 April 2014. Pratt & Whitney PT6A engine series was initially endorsed on his licence on 2 April 2014. The AME was reissued a licence on 16 May 2020 with an expiry date of 10 April 2022, and the PT6 series engine was endorsed on it.

1.6. Aircraft Information

1.6.1 The PA-46-350P Jetprop DLX is a six-seat, low-wing, pressurised aircraft equipped with retractable landing. The aircraft is certified in the normal category and is approved for day and night Visual Flight Rules (VFR) and Instruments Flight Rules (IFR) operations. The

accident aircraft, originally a PA-46-350P powered by a Lycoming TIO-540-AE2A 350-horsepower, turbocharged reciprocating engine, was manufactured in 1989. A Supplemental Type Certificate (STC) ST00541SE was incorporated by Rocket Engineering Corporation in the USA on the aircraft, and the final acceptance test was on 27 December 2010 at 240.3 hours total time since new (TTSN). The STC entails the fitment of a Pratt & Whitney PT6A-35 engine and an MT propeller. The conversion also entailed major changes to the existing airframe, such as new engine mountings, redesigned cowling, fuel system (header tank), engine controls, indicating instruments, electrical systems, pressurisation system, control switches and backup vacuum system.

1.6.2 The PT6A-35 is a turboprop engine driving a propeller via a two-stage reduction gearbox. Two major rotating assemblies compose the heart of the engine: firstly, the compressor and the compressor turbine (compressor section); secondly, the two power turbines and the power turbine shaft (power section). The two rotors are not connected, and they rotate at different speeds and in opposite directions. The compressor draws air into the engine via an annular plenum chamber (inlet case), air pressure increases across three or four axial stages and one centrifugal stage and is then directed to the combustion chamber. Air enters the combustion chamber via small holes. At the correct compressor speed, fuel is introduced into the combustion chamber via 14 fuel nozzles. Two spark igniters located in the combustion chamber ignite the mixture. The hot gases generated by the combustion are then directed to the turbine area. At this point, ignition is turned off since a continuous flame now exists in the combustion chamber. The hot expanding gases accelerate through the compressor turbine vane ring and cause the compressor turbine to rotate (which rotates the compressor at approximately 39 000rpm). The expanding gases travel across the first and second stage power turbines which provide rotational energy to drive the propeller shaft. The reduction gearbox reduces the power turbine speed (approximately 30 000rpm) to one suitable for propeller operation (1 700 / 2 000rpm).

Airframe:

Manufacturer/Model	Piper Aircraft Corporation	
Model	PA-46-350P Jetprop DLX	
Serial Number	4636430	
Year of Manufacture	2007	
Total Airframe Hours (At Time of Accident)	909.9	
Last MPI (Date & Hours)	11 June 2020	875.3
Hours Since Last MPI	34.6	
C of A (Original Issue Date)	15 June 2011	
C of A Expiry Date	30 June 2021	
C of R (Issue Date) (Present Owner)	20 May 2011	

Operating Categories	Part 91
Type of Fuel Used in the Aircraft	Jet-A1
Previous Accidents/Incidents	This aircraft was involved in an incident in 2015 when the pilot landed at Harrismith Aerodrome and the propeller was entangled in a roll of barb wire that was on the runway. The propeller and the engine were removed following this incident. All four propeller blades were replaced, and the propeller was overhauled at the same time. The engine was sent to an approved engine maintenance organisation for a shop visit.

1.6.3 The last Mandatory Periodic Inspection (MPI) was carried out on 11 June 2020 at 875.3 airframe hours. The aircraft was issued a Certificate of Release to Service (CRS) on 11 June 2020 with an expiry date of 11 June 2021 or at 975.30 airframe hours, whichever occurs first. The aircraft had operated 34.6 hours since its last MPI.

1.6.4 The reported engine power loss (torque) was recorded in the flight folio on 6 January 2021 and there were no other flights recorded although the aircraft was flown on 8 January 2021. On 13 January 2021, the aircraft was involved in an accident. There were no records of fuel log in the flight folio between 23 September 2020 and 13 January 2021. The aircraft flew a total of 16.7 hours between 23 September 2020 and 13 January 2021. It was not possible to establish how much fuel was in the aircraft at the time of accident as the pilot was not keeping records as required by regulation.

Non-recording of fuel uplifts is a contravention of Part 91 of the Civil Aviation Regulations (CAR) 2011 as amended, which states the following:

91.03.6 *Fuel record*

(1) The owner or operator shall maintain fuel records to enable the Director to ascertain that, for each flight under his or her control, the requirements of regulation 91.07.12 are complied with.

(2) The PIC of the aircraft shall enter the fuel and oil records referred to in sub-regulation (1) in the flight folio.

(3) The owner or operator shall maintain oil records to enable the Director to ascertain that trends for oil consumption are such that an aircraft has sufficient oil to complete each flight.

1.6.5 This aircraft type uses Jet-A1 fuel; the fuel capacity is 170 US gallons of which 160 US gallons was usable.

Engine:

Manufacturer/Model	Pratt & Whitney, PT6A-35
Serial Number	PCE-RR0208
Hours Since New	669.6
Hours Since Overhaul	Not yet reached

Note: engine overhaul interval is 3600 hours

1.6.6 According to the engine logbook, the engine was re-installed on 12 August 2015 at a total time of 333.9 hours and 390 total engine cycles. At the time of the accident, the engine had operated for 335.7 hours since installation. The AMO that was maintaining the aircraft did not remove the B-nuts at any time as it was not required to perform a compressor wash. The nuts in question were still secured by locking wire when the engine arrived at the service centre in Canada.

Propeller:

Manufacturer/Model	MT Propeller / MTV-16-1-E-C-F-R(P)
Serial Number	110070
Hours Since New	669.6
Hours Since Overhaul	335.7

Note: propeller overhaul interval is 3600 hours

1.6.7 Description of compressor wash according to the engine manufacturer's Aircraft Maintenance Manual (AMM):

Compressor wash:
Function.
Atmospheric pollutants may contaminate the engine gas path, leading to a build-up of deposits on aerofoils, the initiation of corrosion, sulphidation or performance deterioration. These effects can be alleviated with engine washing. Internal engine washes are done while motoring the engine at 10-25% Ng speed for a thorough cleaning.
Promote parts life and reduce potential overhaul costs.

Prior to washing, make sure that:

– 40 minutes minimum cooling period is allowed
*– P3 line going to the FCU is removed**
– Cabin bleed is off - No power extraction

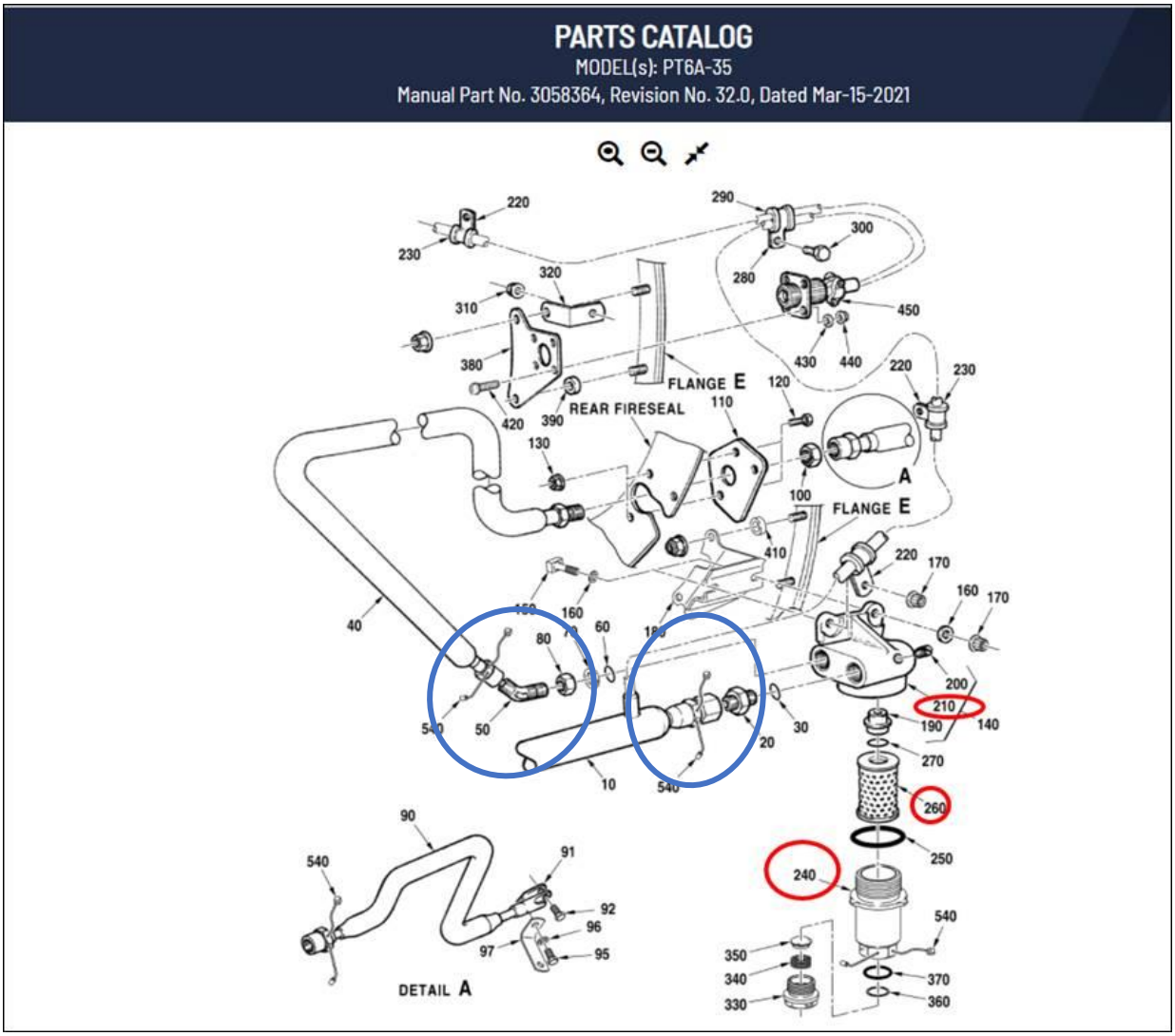

Diagram 1: Schematic diagram of a P3 air filter and the B-nuts.

Follow starter limitations

- Ensure removal of exhaust duct drain plug if installed.

After Wash Procedure:

- Reconnect P3 line to the FCU

Compressor Desalination Wash

Used to remove salt deposits which can cause corrosion, however, light dirt deposits may also be removed. Wash fluid is drinking quality water, provided minimum standards are met. Water is injected into the engine intake using either an installed compressor wash ring or a hand-held wash wand.

Compressor Turbine Desalination Wash

Used to remove salt deposits from the compressor turbine blades and stator which can cause sulphidation, a reaction between the salt and sulphur from the fuel. This wash must be done immediately following a compressor desalination or performance recovery wash as contaminants will be transferred from the compressor to the hot section during a compressor

desalination or performance recovery wash. Wash fluid is drinking quality water, provided minimum standards are met. Water is injected through a wash tube inserted through one of the ignitor ports.

Compressor Performance Recovery Wash
Recommended every 100 - 200 hrs based on the flying environment.
Used to remove more stubborn deposits which cannot be removed during normal desalination washes. Wash fluid includes an approved detergent. This wash should only be done when engine performance loss is noticeable or trend monitoring dictates. Wash fluid is injected into the engine intake using either an installed compressor wash ring or a hand-held wash wand. A water rinse of both the compressor and compressor turbine is required following the detergent wash.

1.7. Meteorological Information

1.7.1 The weather information in the table below was obtained from the South African Weather Service (SAWS) recorded at Pongola weather station on 13 January 2021 at 0600Z, which is the closest station to Koedoesberg Game Farm, located 6nm (10 kilometres) from the accident site.

Wind Direction	095°	Wind Speed	3kts	Visibility	CAVOK
Temperature	25°C	Cloud Cover	Nil	Cloud Base	Nil
Dew Point	22°C	QNH	1017 hPa		

1.8. Aids to Navigation

1.8.1 The aircraft was equipped with standard navigational equipment as required by the Regulator (SACAA) for the aircraft type. There were no recorded defects with the navigation equipment prior to the flight.

1.9. Communication

1.9.1 The aircraft was equipped with standard communication equipment as required by the Regulator for the aircraft type. There were no recorded defects with the communication equipment prior to the flight.

1.10. Aerodrome Information

1.10.1. The aircraft took off from Koedoesberg Game Farm private airstrip. Prior to the accident, the aircraft was parked in the hangar at Koedoesberg farm.

1.11. Flight Recorders

1.11.1 The aircraft was not fitted with a cockpit voice recorder (CVR) or a flight data recorder (FDR), and neither is required by regulation to be fitted to this type of aircraft.

1.12. Wreckage and Impact Information

1.12.1 The accident occurred shortly after take-off from Runway 29 at Koedoesberg private airstrip on a gravel road approximately 500m from the threshold of Runway 11 following an engine power loss. The gravel road serves as a fire break between the sugar cane fields and is 5m wide. The aircraft veered off to the right and came to rest on the verge of the road. The undercarriage collapsed, and all four propeller blades were severed at their respective roots. The fuel tanks ruptured and there was an indication of fuel spillage on the ground during recovery. It could not be determined how much fuel leaked and how much fuel was in the aircraft at the time of accident.

Figure 4: The aircraft as it came to rest. (Source: Owner)

Figure 5: Engine controls of the aircraft post-accident.

1.12.2 The throttle lever was found in full forward position. The pitch lever was in full fine position.

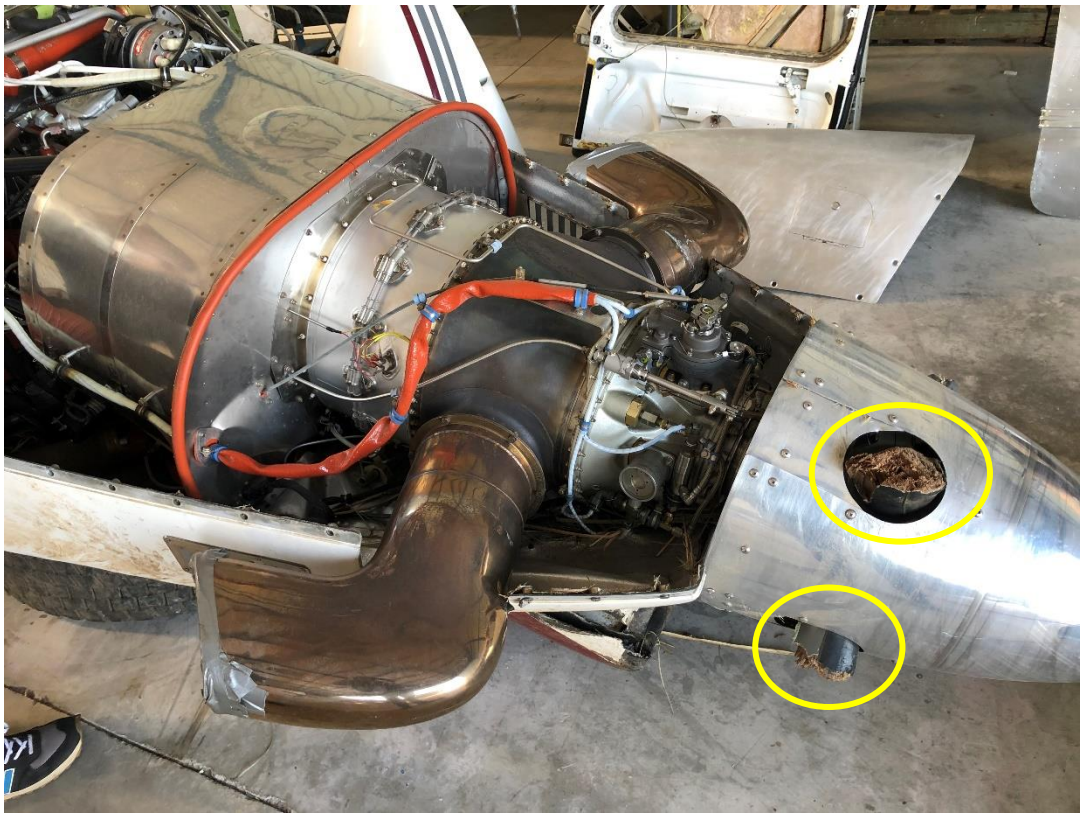

Figure 6: Three of the four propeller blades visible in this picture, which were severed at the roots.

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 there was no damage to the cockpit and cabin areas.

1.16. Tests and Research

1.16.1 The aircraft was recovered to an AMO at FAWB. On 21 January 2021, a borescope inspection was conducted by an engine field representative in the presence of the investigation team. There was no evidence found that the engine sustained any internal nor external damage. It was decided that the engine be removed from the airframe and shipped to the engine manufacturer service centre in Canada for further investigation.

1.16.2 Approximately 60 millilitres (ml) of fuel was drained from the right-wing collector tank by the AMO and it was found to have evidence of contamination (see Figure 7).

1.16.3 The chemical analysis of the fuel sample drained from the fuel pump filter was carried out by the engine manufacturer during the investigation at their facilities. This is the summary: *"the chemical foot print of the fuel sample is similar to Kerosene. There was not enough fuel to do a full test to compare with the specificatio*n *and to make an assessment of its characteristics. However, based on the observation of the fuel sample and engine disassembly, it is not probable that the fuel itself contributed to the engine power loss." (SIC)*

Figure 7: Contaminated fuel drained from the right-wing collector tank.

Figure 8: Fuel filter.

Figure 9: The fuel filter after it was removed from the filter housing.

1.16.4 The following information is an extract from the engine manufacturer's factual notes:

> *Compressor Discharge Air (P3) and P3 Filter: Compressed air was applied to the P3 air filter housing and leak-check fluid was applied on all the connections. Both P3 lines at the P3 air filter housing were leaking as shown with red arrows. Manipulation of the flexible portion of P3 line (between the FCU and P3 air filter housing) during the leak check made the leak at the B-nut worse. There were no other leaks along the P3 line. The lock wire was in the correct orientation. The P3 air filter showed environmental dust on the external surfaces.*

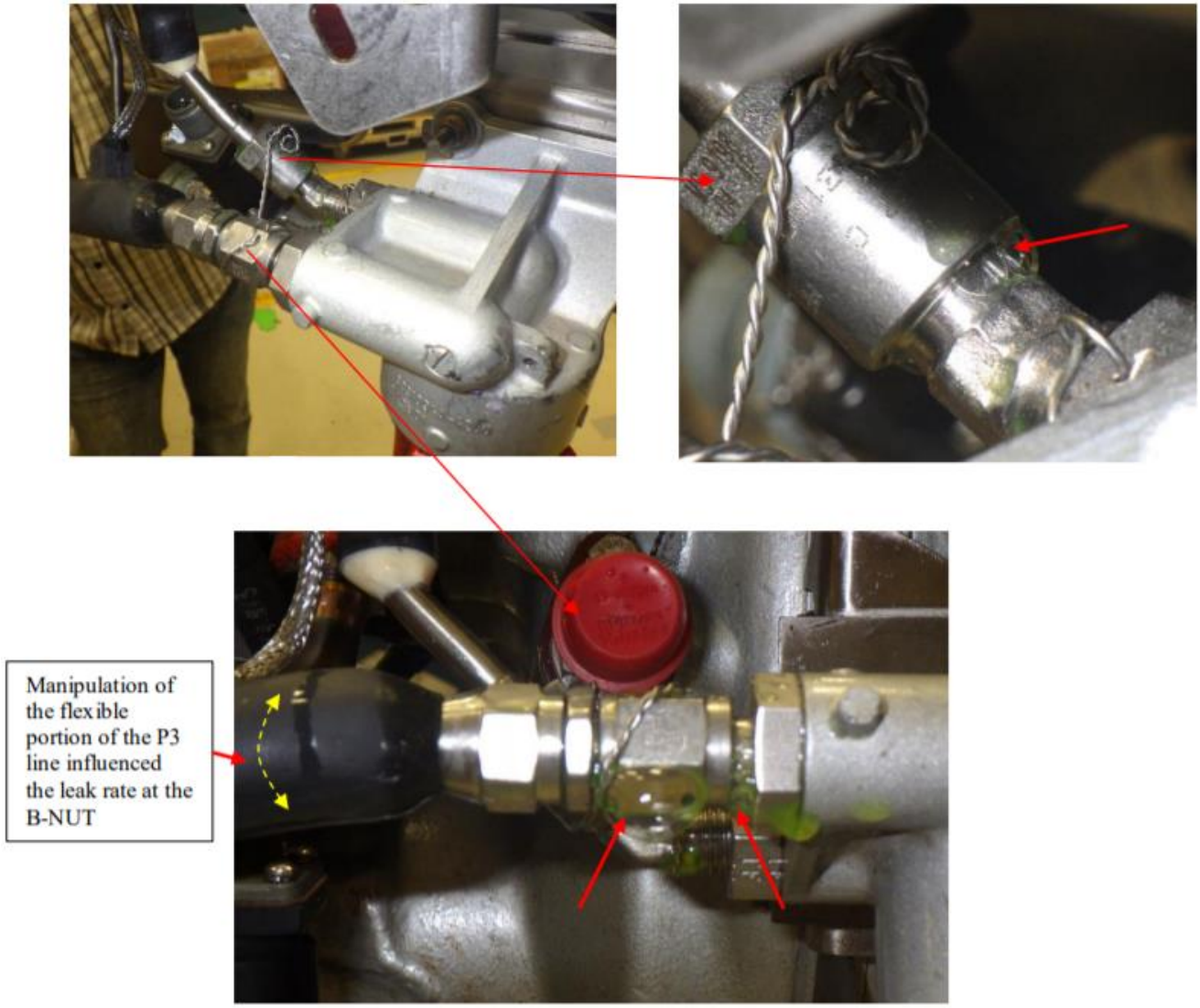

Figure 10: The leak location where the B-nuts attach to the P3 air-filter.

1.16.5 *Removal of the lock wire showed that both B-nuts at the P3 filter housing were loose, they unscrewed with no resistance. The condition of the threaded portion of both B-nuts and respective fittings did not show any visual damage that would have prevented tightening to the required torque. According to the maintenance manual, the required torque is 90-100 in.lb (inch pounds).*

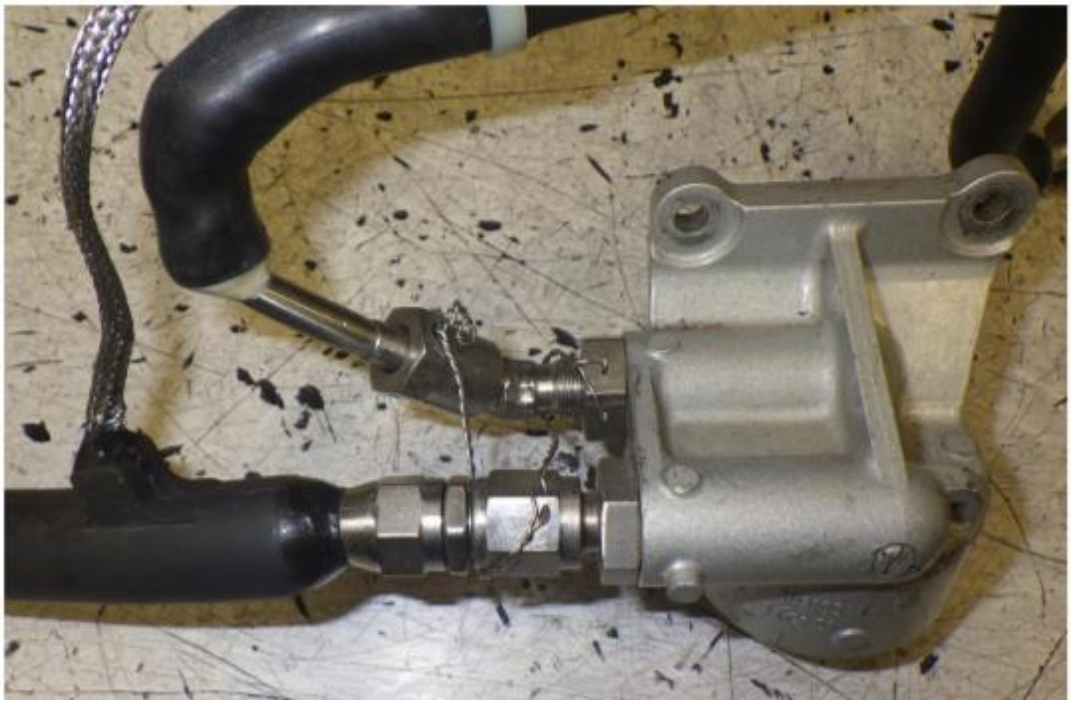

Figure 11: Loose B-nuts that were removed from the engine.
(Source: Technical report from the engine manufacturer)

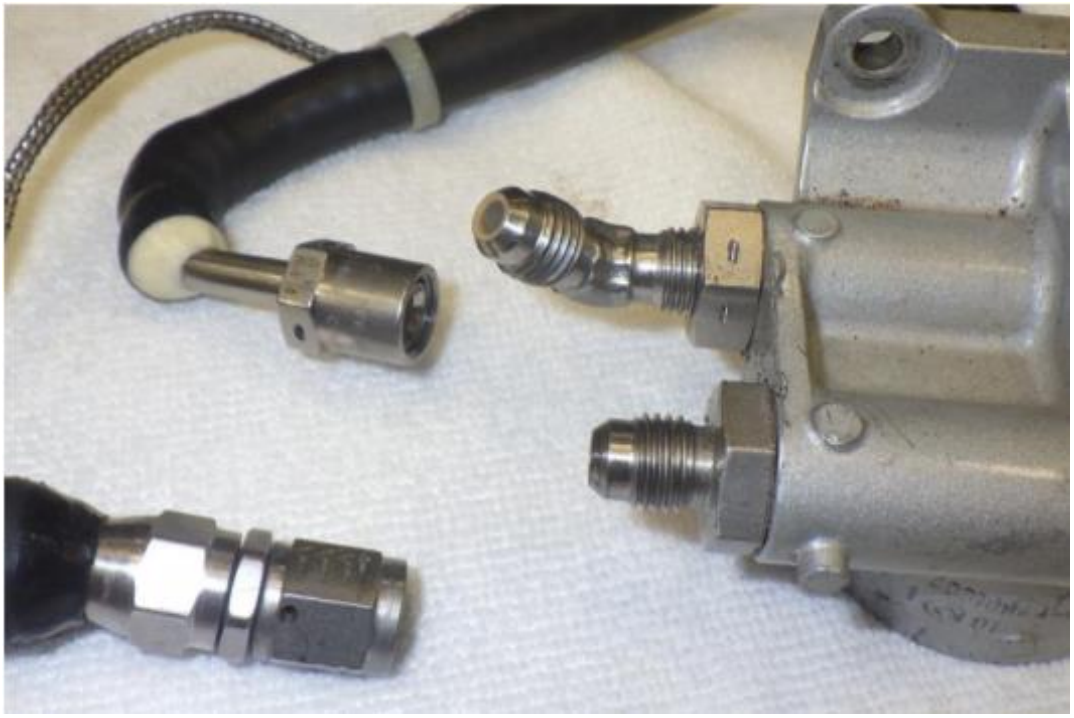

Figure 12: Loosened B-nuts from the P3 filter housing.
(Source: Technical report from the engine manufacturer)

1.16.6 *Power Turbine Control (PY): Py line was continuous from the FCU to the constant sector unit (CSU) and the B-nuts were tight and secured. Examination of the engine displayed two loose B-Nuts at the P3 filter housing. A leak test revealed that both locations were leaking. The condition of the threads in both locations did not show any evidence that would have prevented proper assembly.*

1.16.7 *Diagrams 2 and 3 illustrate troubleshooting of engine power loss as contained in the PT6 maintenance manual part no.3058362. Section 72-00-00.*

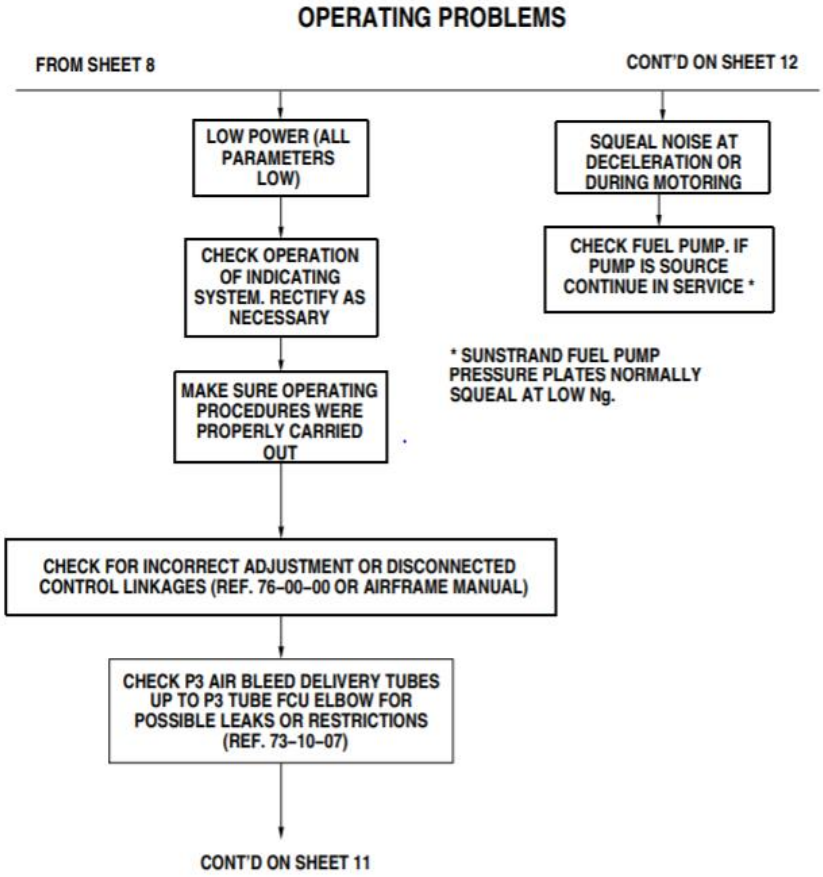

Diagram 2: Troubleshoot of engine power loss. (Source: PT6 maintenance manual)

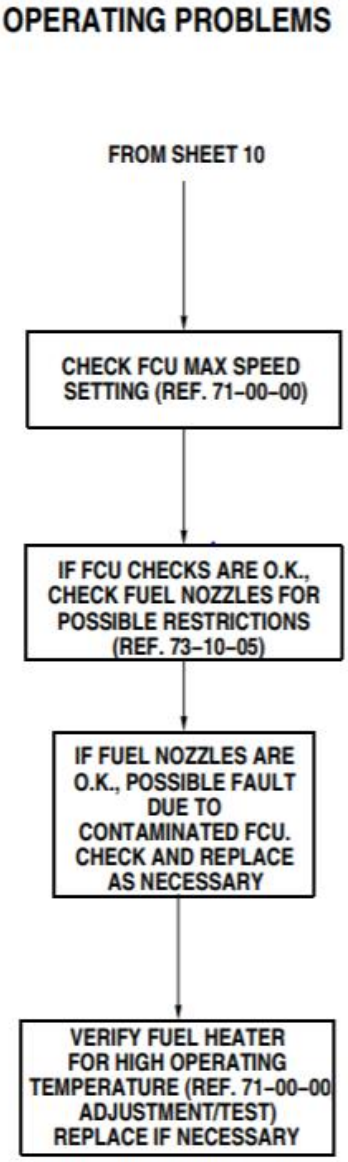

Diagram 3: Troubleshoot of engine power loss. (Source: PT6 maintenance manual)

1.16.8 The FCU and Fuel Pump

The FCU with part number 3122696-03 and serial C25955 (vendor – Honeywell) and fuel pump with part number 3034794 and serial number 003111 (vendor – Triumph) were removed as a pack and sent for tests. The FCU was separated from the fuel pump and the Nylon coupling was in place and in a good condition.

Fuel Control Unit

External condition	Presence of dark deposit on the external housing the bellows side was noted. The levers were moving freely on their entire travel. The drive shaft was rotating by hand with the usual resistance. There were some blue splatters on the drive shaft bearing retaining plate. The rubber data plate was illegible. The acceleration adjustment cup indication was in line with the bypass valve colour. The part power trim was in the running position.

Test Results	The metering valve orifice and bypass valve differential pressure was 2 PPH above the maximum requirement (Minimum fuel flow setting). The enrichment spring setting was 11 PPH below the minimum limit. The governor spring setting was 45 PPH over the maximum limit. This is a permissible adjustment. The maximum idle reset stop adjustment was 102 PPH below the minimum limit. This is a permissible field adjustment. The manual override was 8 PPH over the maximum limit. The cut-off modulation was 162 PPH above the maximum limit.
Detailed disassembly sequence and results	Based on the test results and the ability of returning the unit to factory settings, the unit was not disassembled for the purpose of this investigation.

Fuel Pump

External condition and cleanliness	The external shaft was generally clean. The driveshaft was rotating by hand. The driveshaft splines were in good condition. A fuel sample was taken from the fuel filter bowl. The fuel sample had no particles in suspension and no appearance of colour separation. Later on, some black particles were present at the bottom of the container. The fuel filter was dirty.
Test Results	Prior to testing, the inlet screen was removed, and small particles were observed on the inlet side. Similar particles were observed in the fuel sample. The fuel pump was satisfactorily tested.
Detailed disassembly sequence and results	Based on the test results, this unit was not disassembled for the purpose of this investigation.

1.16.9 The following information is an extract from the fuel sample analysed by the engine manufacturer:

Sample List
1. Fuel sample
Procedure
The fuel sample was analysed by gas chromatography (GC) to determine the presence of any liquid contamination.
A portion of the fuel was filtered through 0.45µm Nylon filter patch to collect the solid particles present in the fuel. One of the filter patches obtained was analysed by Automatic particles analysis (APA) methodology. A portion of the residue from the patch and some larger particles were taken from the patch and analysed by scanning electron microscope (SEM-EDX).
Results
The GC analysis showed the LCPMC79024 (fuel) fingerprint with traces of slightly less volatile peaks, the peaks observed cannot be associated to any compound available in our database.

Therefore, we cannot determine if these peaks are from a contamination or from less volatile fraction present in this fuel sample that we don't see in the LCPMC79024 standard available at the chemical laboratory.
The SEM-EDX analysis on the larger metallic particles:
- Most of the particles analysed were composed of Aluminium alloy. Size up to ~180x15µm.
- One Iron rich particle containing high level of Nickel. Size: ~70x45µm.
- One Copper rich particle containing Zinc and suggesting brass. Size: ~115x10µm
The SEM-EDX analysis on the residue from the patch showed:
- A residue composed of Carbon, Oxygen, Iron, Calcium, Silicon with few Aluminium, Sulphur, Nickel and traces of Sodium, Magnesium, Phosphorous, Potassium, Chromium, Zinc and Molybdenum.
- Presence of Carbon rich particles suggesting either organic base particles or carbonaceous particles
- Calcium rich particles
- Aluminium rich particles
- Iron rich particles
- Silicon rich particles
The APA analysis showed:
- Mainly Iron base particles with particles similar to carbon steel, 400 series SST and low alloy steel, including some particles suggesting alloy similar to UNS G93106 and to UNS K71040.
- Traces of Nickel rich particles, which could suggest the presence of Nickel plating.
- Traces of Silicon rich particles
The APA analysis also showed interaction between Iron base alloy similar to 400 series SST and Nickel rich particles.

1.17. Organisational and Management Information

1.17.1. This was a private flight conducted under the provisions of Part 91 of the Civil Aviation Regulations (CAR) 2011 as amended.

1.17.2. The AMO that carried out the MPI prior to the accident flight was in possession of an AMO certificate which was issued by the SACAA on 1 September 2020, with an expiry date of 31 August 2021. The last audit at the AMO was conducted on 27 July 2020. According to the Operations Specifications, the AMO had the required ratings and had been authorised to carry out maintenance on the aircraft type.

1.18. Additional Information

1.18.1 The following information of operation of FCU was obtained from the aircraft's maintenance manual:

The fuel control system consists of three separate units with interdependent functions: The Fuel Control Unit (FCU), a Propeller Governor and a Starting Flow Control. The FCU determines the proper fuel schedule for engine steady state operation and acceleration/deceleration. The starting flow control acts as a flow divider, directing FCU metered fuel output to the primary fuel manifold or to both primary and secondary manifolds as required. Full propeller control during forward and reverse thrust operation is provided by

a governor package which contains a normal propeller control during forward and reverse operation is provided by a governor package which contains a normal propeller governor (CSU) section, a reversing valve, and a power turbine governor section (Nf), (in early engine models this function is provided by a separate unit). The Nf governor section provides power turbine overspeed protection during normal operation. During reverse thrust operation the propeller governor is inoperative, and control of power turbine speed is accomplished by the Nf governor section.

The fuel control unit (FCU) is mounted on the engine driven fuel pump and is driven at a speed proportional to compressor turbine speed (Ng). The FCU determines the fuel schedule for the engine to provide the power required as established by the power lever. This is accomplished by controlling the speed of the compressor turbine (Ng). Engine power output is directly dependent upon compressor turbine speed. The FCU governs Ng thereby actually governing the power output of the engine. Control of Ng is accomplished by regulating the amount of fuel supplied to the combustion section of the engine.

1.18.2 The following information is extracted from the Pilot's Operating Handbook:

ENGINE POWER LOSS DURING TAKE-OFF (3.3c)
The proper action to be taken if loss of power occurs during take-off will depend on the circumstances of the particular situation. If sufficient runway remains to complete a normal landing, leave the landing gear down and land straight ahead. If the area ahead is rough, or if it is necessary to clear obstructions, move the landing gear selector switch to the UP position and prepare for a gear up landing. If time permits, move mixture control to idle cut-off, turn OFF the emergency (EMERG) fuel pump, move the fuel selector to OFF and, after the landing gear is retracted, turn battery master switch OFF. If sufficient altitude has been gained to attempt a restart, maintain a safe airspeed, turn the emergency (EMERG) fuel pump ON, and switch the fuel selector to another tank containing fuel. Ensure the mixture is full RICH and move the induction air lever to the ALTERNATE position.

If normal engine operation and fuel flow are not re-established, the emergency (EMERG) fuel pump should be turned OFF. The lack of a fuel flow indication could indicate a leak in the fuel system. If fuel system leak is verified, switch fuel selector to OFF. If engine failure was caused by fuel exhaustion, power will not be regained after switching fuel tanks until the empty fuel lines are filled. This may require up to ten seconds. If power is not regained, proceed with Power Off Landing procedure

The following information is an extract from Civil Aviation Regulations (CAR) 2011 Part 91 as amended:

Flight folio

91.03.5 (*1) The owner or operator of a South African registered aircraft shall ensure that the aircraft carries a flight folio or any other similar document which meets the requirements of and contains the information as prescribed in Document SA-CATS 91, at all times.*

(2) The flight folio shall be kept up-to-date and maintained in a legible manner by the PIC.

(3) All entries shall be made immediately upon completion of the occurrence to which they refer.

(4) In the case of maintenance being undertaken on the aircraft, the entry shall be certified by the person taking responsibility for the maintenance performed.

(5) The owner or operator shall retain the flight folio for a period of 5 years calculated from the date of the last entry therein.

Fuel record

91.03.6 (*1) The owner or operator shall maintain fuel records to enable the Director to ascertain that, for each flight under his or her control, the requirements of regulation 91.07.12 are complied with.*

(2) The PIC of the aircraft shall enter the fuel and oil records referred to in sub regulation (1) in the flight folio.

(3) The owner or operator shall maintain oil records to enable the Director to ascertain that trends for oil consumption are such that an aircraft has sufficient oil to complete each flight.

1.19. Useful or Effective Investigation Techniques

1.19.1. None.

2. ANALYSIS

2.1. General

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

2.2. Analysis

Man

2.2.1 The pilot was initially issued a Private Pilot Licence (Aeroplane) on 21 July 1972, and validation was carried out on 20 January 2020 with an expiry date of 31 January 2021. The pilot was issued a Class 2 aviation medical certificate on 10 January 2020 with an expiry date of 31 January 2021. The pilot had a valid medical certificate.

2.2.2 The pilot was well aware that the engine reduction in power issue after take-off was not resolved by the time he conducted the flight on 13 January 2021. He made a conscious decision to fly the aircraft and he encountered the same situation, which resulted in him executing a forced landing. The situation the pilot found himself in on the day was the effect of him ignoring advise from the AME and the engine manufacturer.

2.2.3 The pilot was seriously injured in the accident as he was not making use of the aircraft equipped shoulder harnesses, resulting in facial injuries following impact on the instrument panel. This was indicative of the pilot's disregard for standard safe operating procedures. The aircraft maintenance engineer (AME) who released the aircraft to service was initially issued an AME Licence on 2 April 2014. Pratt & Whitney PT6A engine series was initially endorsed on his licence on 2 April 2014. The AME was reissued a licence on 16 May 2020 with an expiry date of 10 April 2022, and the PT6 series engine was endorsed on it.

Machine

2.2.4 The last MPI was carried out on 11 June 2020 at 875.3 hours and was signed out by a licensed and qualified engineer who had the aircraft type endorsed on his licence. Following the MPI, the aircraft had flown a further 34.6 hours. There was a recurring defect of engine power loss at different occasions that was experience by the pilot. The Accountable Manager from the AMO troubleshot and conducted engine tests and no faults were found. The Accountable Manager, after consulting with the engine manufacturer, advised the owner/pilot that the FCU needed to be removed from the engine and sent to the engine manufacturer for investigation.

2.2.5 During the fault-finding process, the pilot/owner opted to obtain a second opinion from an independent PT6 engine expert. The expert and the AME that maintained the aircraft went on a flight with the pilot to access the engine performance. It was, however, found that the engine performed normally and no reduction in power was noted during the flight.

2.2.6 This aircraft/engine was fitted with a compressor wash kit, which did not require that any tubing be removed from the engine to perform the wash by the AMO.

2.2.7 Following a borescope inspection that was conducted on the engine on 21 January 2021, the engine did not display any evidence of internal or external damage. The engine was then removed from the airframe and was sent to the engine manufacturer service centre in Canada for further investigation.

2.2.8 During the examination of the engine, two loose B-nuts were found at the P3 filter housing. A leak test was performed, and it was found that air was leaking at both these locations. Both these B-nuts were still in the wire locked position during examination. It could not be established when these B-nuts were last disturbed (loosen) as the aircraft was fitted with a compressor wash kit, which did not require the removal of the B-nuts at the P3 filter housing to perform the task. The FCU and fuel pump were removed from the engine and inspected. According to available information, nothing untoward was found with either of these units.

2.2.9 As the power loss defect was intermittent, the AMO was unable to determine the cause of power loss as this was not experienced during test runs and flights. The intermittent or insufficient air was supplied to the FCU because of the air leak at the B-nuts at the P3 filter housing; this would have resulted in a reduction in engine power during all flights as not enough fuel would have been supplied to the engine to ensure optimal engine performance is met during all flight conditions. The air leak at the B-nuts may have resulted in insufficient P3 air being supplied to the FCU, which could have caused a reduction in engine power during take-off, and thus, the forced landing.

2.2.10 The absence of a proper fuel uplift history/records as required to be entered in the flight folio for this aircraft was of concern; without the information it was not possible to establish when was fuel uplifted, where it was uplifted, and whether it met the engine operational requirements. The possibility that the pilot/owner was a farmer and could have sourced ‘fuel’ from alternate sources other than a registered fuel supplier, could not be ruled out. It may be likely that during the time he owned and operated the aircraft, this might have had an effect on the fuel components. It should be noted that neither the FCU nor the fuel pump was subjected to a disassembly procedure during the engine examination at the engine manufacturer service centre; therefore, it is not known if the fuel that was used had any effect on the internal parts of these two units and/or any other fuel-related components that were fitted on the engine. It is evident that the fuel filter was dirty and that a small amount of contamination was present in the fuel sample that was drawn from the right-wing header tank. The small amount of fuel that was drained from the fuel filter housing at the service centre was not enough to conduct a proper chemical test. Therefore, the effects of the fuel used on the engine performance could not be ignored.

2.2.11 The fact that all four propeller blades were severed at their respective roots indicated that the engine was still delivering a substantial amount of power at ground impact.

3. CONCLUSION

3.1. General

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

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

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

3.2. Findings

3.2.1 The pilot was initially issued a Private Pilot Licence (Aeroplane) on 21 July 1972, and validation was carried out on 20 January 2020 with an expiry date of 31 January 2021. The pilot was issued a Class 2 aviation medical certificate on 10 January 2020 with an expiry date of 31 January 2021.

3.2.2 The pilot/owner was informed by the Accountable Manager of the AMO via WhatsApp on 21 December 2020 not to fly the aircraft until the reduction in engine power matter was been resolved.

3.2.3 The pilot was seriously injured in the accident and was admitted to hospital. He was not wearing the aircraft equipped shoulder safety harness at the time of accident and his face impacted the instrument panel.

3.2.4 The first responder to the accident scene stated that the engine was still running when he arrived, and he switched it off.

3.2.5 The aircraft was issued a Certificate of Registration on 20 May 2011.

3.2.6 The aircraft was issued a Certificate of Airworthiness on 15 June 2011 with an expiry date of 30 June 2021.

3.2.7 The last MPI was carried out on 11 June 2020 at 875.3 hours, with the next MPI due on 11 June 2021 or at 975.30 hours, whichever occurs first.

3.2.8 The aircraft was issued a Certificate of Release to Service (CRS) on 11 June 2020 with an expiry date of 11 June 2021 or at 975.30 hours, whichever occurs first.

3.2.9 According to the engine logbook, the engine was installed on 12 August 2015 after it was removed from the aircraft following an incident the aircraft was involved in, at a total time of 333.9 hours and 390 total engine cycles. The engine was operated for 335.7 hours since installation. As the investigator did not have logbooks, therefore, no comments could be made on the hours flown.

3.2.10 Examination of the filter housing revealed that the engine displayed two loose B-nuts at the P3 filter housing. A leak test revealed that there was a leak at the location where the B-nuts attach to the P3 lines. The B-nuts were not torqued to the correct torque value that is stipulated in the AMM. The torque value for the B-nuts is 90-100 lbs.

3.2.11 The private flight was conducted under the provisions of Part 91 of the CAR 2011 as amended and in Visual Flight Rules (VFR) by day.

3.2.12 The reported engine power loss (torque) was recorded in the flight folio on 6 January 2021 and there were no other flights logged, although the aircraft was flown on 8 January 2021. On 13 January 2021, the aircraft was involved in an accident. There were no records of fuel log in the flight folio between 23 September 2020 and 13 January 2021. The aircraft flew a total of 16.7 hours between 23 September 2020 and 13 January 2021. It was not possible to establish how much fuel was uplifted in the aircraft at the time of accident as the pilot was not keeping records as required by regulation.

3.2.13 A small amount of fuel that was drained from the right-wing collector tank displayed some contamination. The fuel tanks were ruptured, and fuel spillage was reported at the crash site following the accident. There was not enough fuel to conduct fuel testing. The fuel filter was found to be dirty.

3.2.14 A borescope inspection was conducted by an engine representative following recovery of the aircraft in South Africa and no evidence was observed that any internal damage was present in the engine, nor was there any external damage.

3.2.15 The chemical analysis of the fuel sample drained from the fuel pump filter was conducted by the engine manufacturer. In summary, the chemical footprint of the fuel sample was similar to Kerosene. There was not enough fuel to perform a detailed fuel analysis.

3.2.16 Based on the observation of the fuel sample and engine disassembly, it is believed that the fuel condition could have contributed to the engine power loss.

3.2.17 During the investigation of the engine and after the removal of the wire locking from the B-nuts on the P3 line and filter, it was established that the B-nuts were not tightened. This resulted in an air leak on the P3 line and filter, which in turn caused insufficient P3 air supply to the FCU.

3.2.18 The weather was not a factor in this accident.

3.2.19 The pilot made an unsuccessful forced landing on a gravel road, which was 5m wide.

3.2.20 The owner of the aircraft, who was also the pilot, contravened Part 91.03.5 of the CAR by not completing the flight folio as required.

3.2.21 The aircraft was fitted with a compressor wash kit which does not require any piping to be removed from the engine in order to perform it (compressor wash).

3.3 Probable Cause/s

3.3.1 Engine power loss in-flight, resulting in an unsuccessful forced landing.

3.4 Contributing Factor/s:

3.4.1 Disregard for standard safe operating procedures by the pilot/owner of the aircraft.

3.4.2 The engine investigation revealed that there was an air leak at the B-nuts that attach to the P3 air-filter housing which supplies air to the fuel control unit. The air leak contributed to the reduction in engine power during this flight.

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 None.

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