AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

				Reference:	CA18/2/3/10564		
Aircraft Registration	ZS-NJD	**Date of Accident**		19 March 2025	**Time of Accident**		1500Z
Type of Aircraft	Piper Aerostar PA-60-600			**Type of Operation**	Private (Part 91)		
Pilot-in-command Licence Type	Airline Transport Pilot Licence (ATPL)		**Age**	29	Licence Valid		Yes
Pilot-in-command Flying Experience	**Total Flying Hours**			2116	**Hours on Type**		234
Last Point of Departure	Bethlehem Aerodrome (FABM), Free State Province						
Next Point of Intended Landing	Wonderboom Aerodrome (FAWB), Gauteng Province						
Damage to Aircraft	Substantial						
Location of the accident site with reference to easily defined geographical points (GPS readings if possible)							
On a private farm, 750m beyond the end of Runway 11 at FABM at GPS co-ordinates: 28°14'56.91"S 028°20'56.81"E, at a field elevation of 5599 feet (ft)							
Meteorological Information	Surface wind: 270°/1kt; temperature: 20°C; dew point 13°C, visibility: 9999m						
Number of People On-board	1+5	**Number of People Injured**	0	**Number of People Killed**	0	**Other (On Ground)**	0

Synopsis

On Wednesday afternoon, 19 March 2025 at 1500Z, a pilot and five passengers on-board a Piper Aerostar PA-60-600 aircraft with registration ZS-NJD took off from Bethlehem Aerodrome (FABM) in Free State province with the intention to land at Wonderboom Aerodrome (FAWB) in Gauteng province.

According to the pilot, the aircraft departed from FAWB in the morning with sufficient fuel for a round trip to FABM. On the return leg before take-off, a pre-flight inspection was conducted, and no faults were found. Thereafter, the pilot taxied the aircraft to Runway (RWY) 11 for take-off. After a normal engine run-up and rotation at 90 knots (kts), the aircraft got airborne but failed to achieve the expected rate of climb; the airspeed decreased, and the aircraft lost altitude. The aircraft touched down 500 metres (m) beyond the end of Runway 11 at FABM and came to a stop 250m from the initial touchdown point between the trees. The pilot and the passengers were not injured; the aircraft sustained damage to the bottom part of the fuselage, propellers and wings leading edges.

The investigation found that the constant-speed propeller cylinder threads were likely cross-threaded during installation, which resulted in damage. This caused the propeller to automatically feather, reducing the aircraft's performance. With only one engine operating, the aircraft experienced a significantly reduced climb rate. Combined with its weight, this made it impossible for the aircraft to clear an obstacle along the flight path. The pilot elected to perform a forced wheels up (belly) landing on a suitable open field near the aerodrome.

Probable Cause/s

The pilot conducted an unsuccessful forced landing after the aircraft lost thrust on the right-side engine. The loss of thrust was a result of the propeller that auto-feathered because of low engine oil pressure which was caused by the propeller pitch-change cylinder loosening due to damaged threads.

Contributory Factors

1. Improper fitment of the propeller hub during maintenance installation.
2. The aircraft was close to its maximum allowable weight which, along with high-density altitude, reduced engine performance and climb ability on one of the engines.

SRP Date	11 November 2025	Publication Date	12 November 2025

Occurrence Details

Reference Number	**:** CA18/2/3/10564
Occurrence Category	**:** Accident (Category 2)
Type of Operation	**:** Private (Part 91)
Name of Operator	**:** Twin City Development
Aircraft Registration	**:** ZS-NJD
Aircraft Make and Model	**:** Aerostar Aircraft Corporation PA-60-600, Aerostar
Nationality	**:** South African
Place	**:** Bethlehem, Free State Province
Date and Time	**:** 19 March 2025 at 1500Z
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 19 March 2025 at 1900Z. The occurrence was classified as an accident according to the CAR 2011 Part 12 and the International Civil Aviation organisation (ICAO) STD Annex 13 definitions. Notifications were sent to the States of Registry, Operator, Design and Manufacturer (United States of America's National Transport Safety Board [USA NTSB]) in accordance with the CAR 2011 Part 12 and ICAO Annex 13 Chapter 4. The State appointed an accredited representative and advisor. The investigator was dispatched to the accident site.

Notes:

1. *Whenever the following words are mentioned in this report, they shall mean the following:*
   Accident — this investigated accident
   Aircraft — the Piper PA-60-600 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
°	Degrees
°C	Degrees Celsius
AFM	Aircraft Flight Manual
AGL	Above Ground Level
AIID	Accident and Incident Investigations Division
AMO	Aircraft Maintenance Organisation
ATPL	Airline Transport Pilot Licence
AVGAS 100LL	Aviation Gasoline 100 Low Lead
CAR	Civil Aviation Regulations
C of A	Certificate of Airworthiness
C of R	Certificate of Registration
CRS	Certificate of Release to Service
CSU	Constant Speed Unit
FABM	Bethlehem Aerodrome
FAWB	Wonderboom Aerodrome
fpm	Feet per minute
ft	Feet
GPS	Global Positioning System
hPa	Hectopascal
kt	Knots
m	Metres
METAR	Meteorological Aerodrome Report
MPI	Mandatory Periodic Inspection
OEM	Original Equipment Manufacture
POH	Pilot Operating Handbook
QNH	Barometric Pressure adjusted to Mean Sea Level
RWY	Runway
SACAA	South African Civil Aviation Authority
SAWS	South African Weather Service
TBO	Time Before Overhaul
UTC	Universal Co-ordinated Time
VMC	Visual Meteorological Conditions
Z	Zulu (Term for Universal Co-ordinated Time – Zero Hours Greenwich)

1. FACTUAL INFORMATION

1.1. History of Flight

1.1.1. On Wednesday afternoon, 19 March 2025 at 1500Z, a pilot and five passengers on-board the Piper Aerostar PA-60-600 with registration ZS-NJD took off from Bethlehem Aerodrome (FABM) in Free State province with the intention to land at Wonderboom Aerodrome (FAWB) in Gauteng province. The flight was conducted under visual meteorological conditions (VMC) and under the provisions of Part 91 of the Civil Aviation Regulations (CAR) 2011 as amended.

1.1.2. According to the pilot's report, the aircraft departed from FAWB in the morning with adequate fuel on-board for the planned flight to Bethlehem Airport (FABM) and back to FAWB. The round trip was scheduled for one day. The outbound flight to FABM was uneventful. Later that day before the return leg to FAWB, the pilot conducted a pre-flight inspection of the aircraft, and no defects (abnormalities) were identified. After boarding the aircraft, the pilot and the passengers taxied to Runway (RWY) 11 and held short for departure.

1.1.3. The pilot completed the standard engine run-up checks before departure, and all the engine parameters were within the normal operating limits (green range). Take-off was commenced, and the aircraft rotated at 90 knots (kts). After take-off, the pilot retracted the landing gear; the wing flaps were retracted to a 15° position. Shortly after becoming airborne, the pilot noticed that the speed was bleeding and that the aircraft was not achieving the expected rate of climb. He then turned the aircraft slightly to the left between two trees. The airspeed decayed, and it was not possible to sustain the flight as the aircraft was losing height. The pilot performed a forced landing on a field straight ahead with the landing gear in the UP position.

1.1.4. The aircraft touched down with its belly approximately 500 metres (m) beyond the end of RWY 11 and skidded on the ground for about 250m; it impacted a small tree with its right wing and swerved to the right before it came to a stop between tall trees facing south.

1.1.5. An eyewitness who was positioned near the hangars adjacent to RWY 11 and photographing the departure stated that the aircraft struggled to gain height (altitude) after rotation. He also noted that the landing gear was retracted just as the aircraft began to descend and, subsequently, impacted the ground.

1.1.6. The pilot and the passengers disembarked from the aircraft unassisted; they were not injured. The aircraft sustained substantial damage to the underside fuselage (belly), both propellers, and both left and right wings leading edges.

1.1.7. The accident occurred during daylight on a private farm about 750m beyond the end of RWY 11 at Global Positioning System (GPS) co-ordinate determined to be 28°14'56.91"South 028°20'56.81"East, at a field elevation of 5599 feet (ft).

Figure 1: An aerial view of the accident site. The inset pictures show the aircraft after take-off. (Source: Google Map)

1.2. Injuries to Persons

Injuries	Pilot	Crew	Pass.	Total On-board	Other
Fatal	-	-	-	-	-
Serious	-	-	-	-	-
Minor	-	-	-	-	-
None	1	-	5	-	-
Total	**1**	**-**	**5**	-	**-**

Note: Other means people on the ground.

1.3 Damage to Aircraft

1.3.1 The aircraft sustained damage to the under fuselage (belly), both wings, both engines and both propellers.

Figure 2: The aircraft post-accident.

1.4 Other Damage

1.4.1 A section of the farm's barrier fence.

1.5 Personnel Information

Pilot-in-command (PIC)

Nationality	South African	Gender	Male	Age	29
Licence Type	Airline Transport Pilot Licence (ATPL)				
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	Night, Instrument and Flight Instructor Grade III ratings				
Medical Expiry Date	31 May 2025 (Class 1)				
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	2116
Total Past 24 Hours	3.6
Total Past 7 Days	3.6
Total Past 90 Days	48.3
Total on Type Past 90 Days	3.6
Total on Type	234

1.5.1. According to available records, the pilot was initially issued a licence by the Regulator (SACAA) on 5 June 2015. He had an Airline Transport Pilot Licence (ATPL) that was issued on 1 July 2024 with an expiry date of 31 May 2025. His Class 1 aviation medical certificate was issued on 14 November 2024 with an expiry date of 30 November 2025.

1.6.1 Aircraft Information

Aircraft Description: (Source: Pilot's Operating Handbook)

1.6.1. *The Piper PA-60-600, also known as the Piper Aerostar 600, is a twin-engine, propeller-driven, light aircraft designed by Ted R. Smith and later manufactured by Piper Aircraft Corporation. The aircraft is equipped with a fully retractable tricycle landing gear that is electro-hydraulically controlled and also allows nose-wheel steering. The aircraft was equipped with two Lycoming IO-540-K1F5 is a six-cylinder, direct drive, horizontally opposed, air-cooled, fuel-injected engine that delivers 290 horsepower at 2 575 RPM. The two Hartzell constant speed propeller were fitted on each engine for thrust propulsion.*

Airframe:

Manufacturer/Model	Aerostar Aircraft Corporation/PA-60-600	
Serial Number	60-0309-114	
Year of Manufacture	1978	
Total Airframe Hours (At Time of Accident)	3 645.7	
Last Inspection (Date & Hours)	2 August 2024	3 616.2
Hours Since Last Inspection	29.5	
CRS Issue Date	2 August 2024	
C of A (Issue Date & Expiry Date)	28 August 2024	30 September 2025
C of R (Issue Date) (Present Owner)	11 October 1995	
Type of Fuel Used	AVGAS 100LL	
Operating Category	Part 91 (Standard Normal Category (Aeroplane)	
Previous Accidents	None	

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

Engine: No.1

Manufacturer/Model	Lycoming/ IO-540-K1F5
Serial Number	L-14346-48A
Hours Since New	3 616.2
Hours Since Overhaul	1 711.1

Engine: No. 2

Manufacturer/Model	Lycoming/ IO-540-K1F5
Serial Number	L-14347-48A
Hours Since New	3 616.2
Hours Since Overhaul	1 711.1

Propeller: No. 1

Manufacturer/Model	Hartzell/ HC-8468-8R
Serial Number	CK 668
Blades Serial Number	(C59531; C59658; C59664)
Hours Since New	3 616.2
Hours Since Overhaul	402.3

Propeller: No. 2

Manufacturer/Model	Hartzell/ HC-C3YR-2UF
Serial Number	CK 3003
Blades Serial Number	F24410; F24421; F24455
Hours Since New	3 616.2
Hours Since Overhaul	402.3

1.6.2. A review of the aircraft maintenance records, including the logbooks (airframe, engines, and propellers), flight folio and mandatory periodic inspection (MPI), was conducted. All manufacturer-issued Service Bulletins (SB) and Service Instructions (SI) letters were complied with by both the aircraft maintenance organisation (AMO) and the operator.

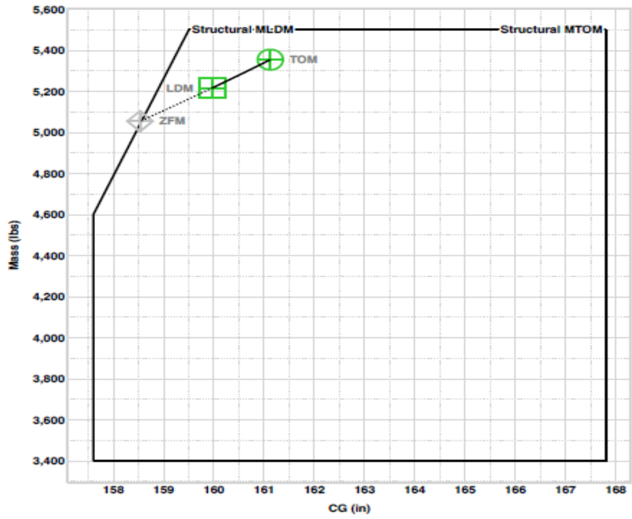
1.6.3. The aircraft had a Certificate of Airworthiness (C of A) that was issued by the Regulator on 3 September 2024 with an expiry date of 30 September 2025. The aircraft was registered to the current owner on 11 October 1995. The last MPI of the aircraft was conducted and certified on 2 August 2024 at 3 616.2 airframe hours. A Certificate of Release to Service (CRS) was issued with an expiry date of 2 August 2025 or at 3 716.2 airframe hours, whichever comes first.

1.6.4. A review of the No.2 propeller with serial number CK 3003 maintenance records showed that it had undergone a mid-life maintenance inspection on 23 January 2024 and had since been in operation for 402.3 hours.

1.6.5. Weight and Balance, and Take-off Performance Calculations

The aircraft is a twin-engine type designed to operate on a single engine after take-off. On the day of the flight, the pilot completed the following performance calculations before departure:

Weight and Balance



Item Description		Mass (lbs)
Souls on board	6	
People		
Cockpit / Pilot		187
Cockpit / Co-pilot		187
Row of Seats 2 / Seat 3		230
Row of Seats 2 / Seat 4		240
Row of Seats 3 / Seat 5		250
Row of Seats 3 / Seat 6		260
Cargo		
Rear Baggage		75

	Mass (lbs)	Limit (lbs)	CG (in)	FWD / AFT Limits (in)
BEM	3,627	-	164.3	157.6 / 167.8
Payload	1,429	1,873	-	-
Zero Fuel Mass	5,056	5,500	158.5	158.6 / 167.8
Wing Fuel Tanks	72	1,000	-	-
Fuselage Fuel Tank	246	260	-	-
Ramp Mass	5,374	5,550	161.3	159.2 / 167.8
Taxi Fuel	18	-	-	-
Takeoff Mass	5,356	5,500	161.1	159.2 / 167.8
Fuel To Destination	138	-	-	-
Landing Mass	5,218	5,500	160.0	158.9 / 167.8

Figure 3: Weight and balance calculations. (Source: Pilot)

The maximum take-off weight (MTOW) for this aircraft is 2 495kg (5 500lbs). The aircraft was 144lbs (65kg) below its MTOW for the flight back to FAWB.

Take off data:

During the pre-flight planning, the pilot conducted the aircraft performance for take-off based on the daily conditions for twin engine operation as well as based on one engine being inoperative. The calculated take-off roll distance at 20° flap settings to clear a 50ft obstacle was determined to be 914m.

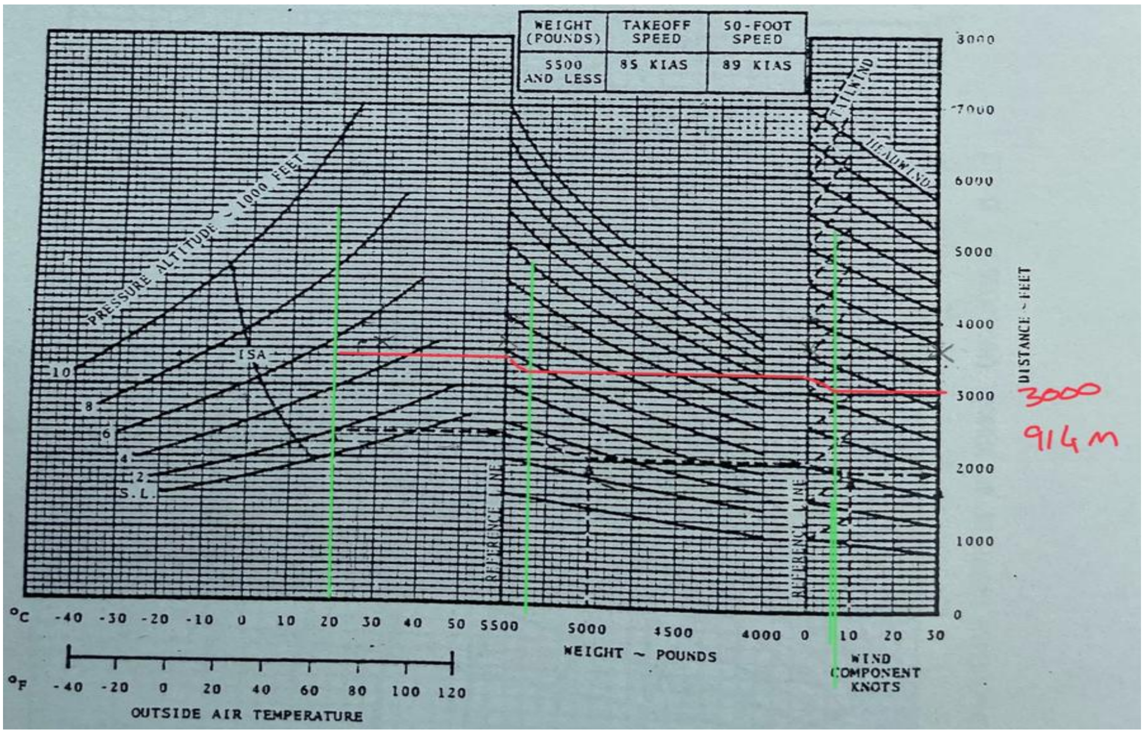


Figure 4: Take-off roll calculation. (Source: Pilot)

The twin-engine calculated rate-of-climb distance performance at maximum normal power was determined to be 1300 feet per minute (fpm).

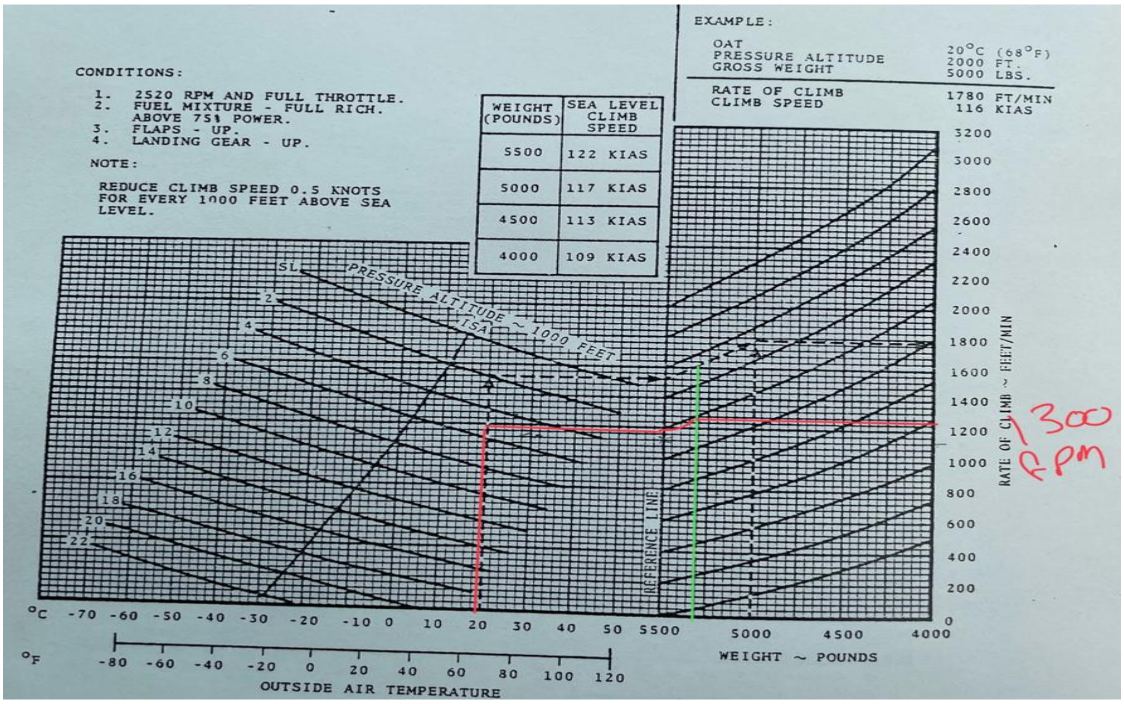


Figure 5: Twin-engine maximum power rate-of-climb calculation.

The single-engine maximum continuous power rate-of-climb calculation was determined to be 80 fpm.

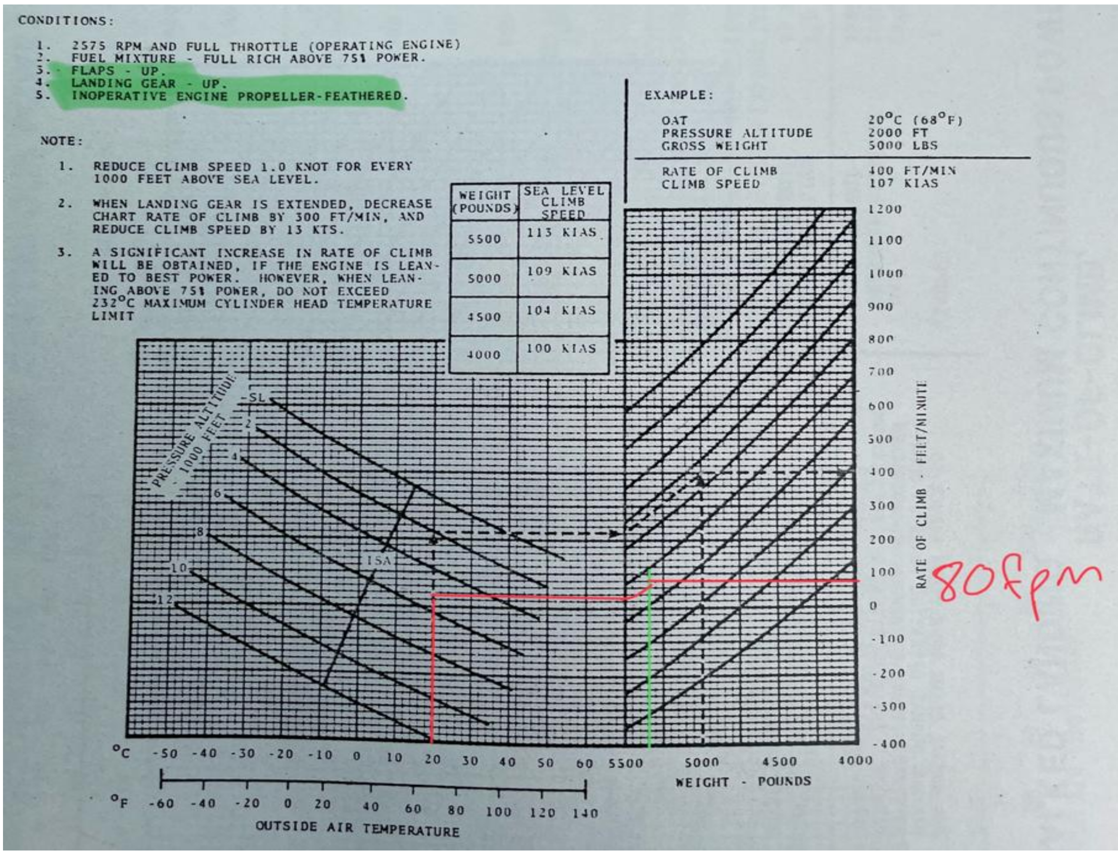


Figure 6: Single-engine continuous power rate-of-climb calculation. (Source: Pilot)

According to the above calculations, the aircraft could take off with a single engine at the time of the flight; however, the reduced rate of climb would not have been sufficient to clear the obstacles beyond the runway.

1.7. Meteorological Information

1.7.1. The weather information below was obtained from the meteorological aerodrome report (METAR) that was issued by the South African Weather Service (SAWS), recorded at FABM on 19 March 2025 at 1500Z.

FABM 191500Z 27001KT 9999 FEW025 FEW035TCU SCT100 20/13 Q1026=

Wind Direction	270°	Wind Speed	1 kt	Visibility	9999 m
Temperature	20°C	Cloud Cover	FEW	Cloud Base	Scattered10 000ft
Dew Point	13°C	QNH	1026hPa		

1.7.2. Density Altitude (Source: https://wahiduddin.net/calc/calc_da.htm)

A Density Altitude calculation was conducted based on the given meteorological conditions on the day. A formular using the following link drew the following conclusion:

Density Altitude Calculator			
Elevation	5561	(●) feet	( ) m
Air Temperature	20	( ) deg F	(●) deg C
Altimeter Setting	1026	( ) in Hg	(●) hPa
Dew Point	13	( ) deg F	(●) deg C
	Calculate	Reset	
Density Altitude	7195 feet	2193 m	
Absolute Pressure	24.7 in Hg	836.4 hPa	
Air Density	0.0616 lb/ft3	0.987 kg/m3	
Relative Density	80.59 %	80.59 %	
Estimated AWOS	7000 feet	2134 m	

The density altitude was 7 195 feet at take-off. Although good weather conditions prevailed at the time of the flight, the density altitude was significantly high to have an impact on the aircraft's performance, especially with one engine being inoperative.

1.8. Aids to Navigation

1.8.1. The aircraft was equipped with standard navigational equipment as approved by the Regulator. There were no records indicating that the navigational equipment was unserviceable prior to the flight.

1.9. Communication

1.9.1. The aircraft was equipped with a standard communication system as approved by the Regulator. There were no recorded defects with the communication system prior to the flight.

1.10. Aerodrome Information

1.10.1. The accident occurred during daylight on a private farm, about 750m beyond the end of RWY 11 at FABM.

Aerodrome Name	Bethlehem Aerodrome (FABM)
Aerodrome Location	Bethlehem, Free State Province

Aerodrome Status	Licensed	
Aerodrome GPS coordinates	28°14'57.43"South, 028°19'54.11"East	
Aerodrome Elevation	5 561ft	
Runway Headings	11/29	13/31
Dimensions of Runway Used	1 175m x 15m	1 311m x 46m
Heading of Runway Used	11	
Surface of Runway Used	Asphalt	
Approach Facilities	None	
Radio Frequency	124.80Mhz (Common traffic advisory)	

Note: The info as per the official aerodrome chart on the SACAA website.

1.11. Flight Recorders

1.11.1. The aircraft was neither equipped with a flight data recorder (FDR) or a cockpit voice recorder (CVR), nor was it required by regulation to be fitted to the aircraft type.

1.12. Wreckage and Impact Information

Figure 7: An overview of the accident site. (Source: Google Earth Maps)

1.12.1. The accident occurred during the take-off phase from FABM (indicated by the green demarcated area in Figure 7). The accident site was on a private farm (blue demarcated area in Figure 7). The ground skid marks stretched over a distance of approximately 250m after touch down, and about 500m beyond the end of the extended centreline of Runway 11. The aircraft remained largely intact with most structural components still attached to the fuselage. The terrain at the accident site comprised several obstacles, including barrier fences and tall trees (see Figure 8).

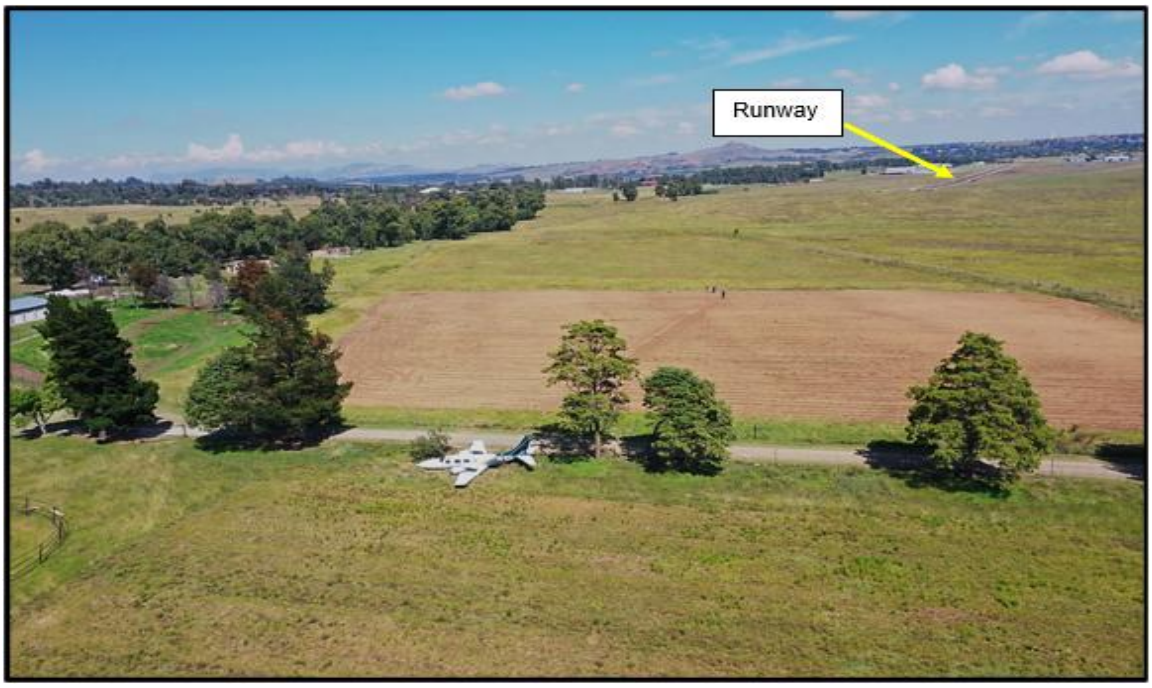


Figure 8: The accident site. (Source: Operator)

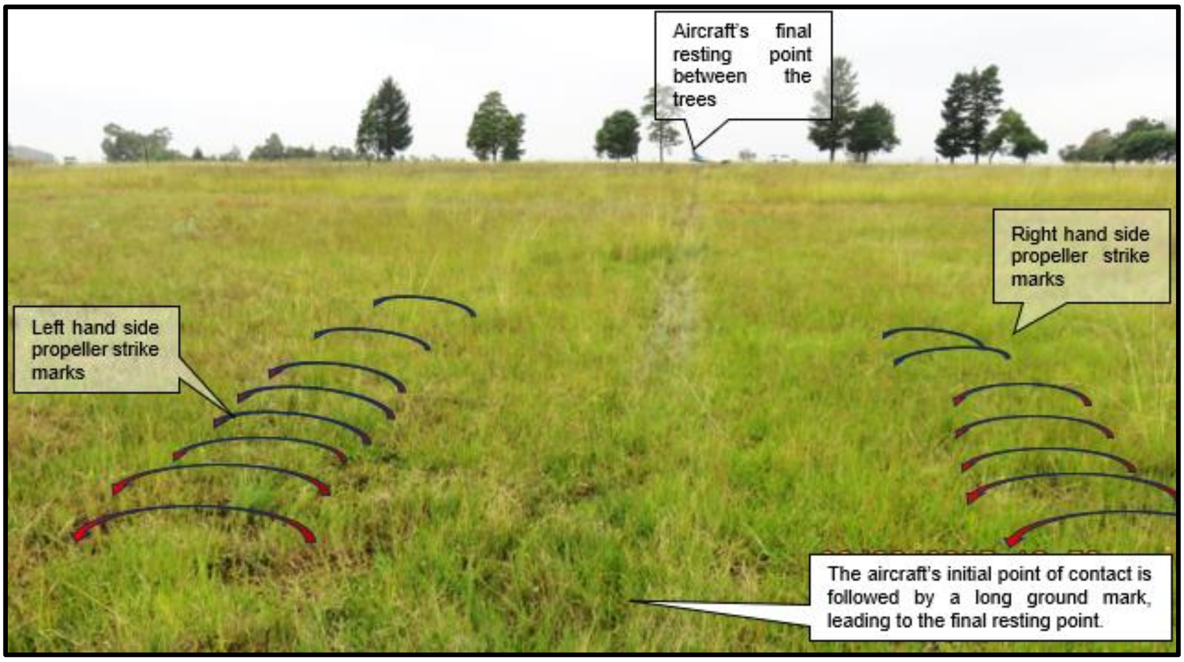


Figure 9: The point at which the aircraft initially touched down.

1.12.2. After rotation, the aircraft was unable to gain a positive rate of climb, and the pilot executed a forced landing; the aircraft crashed shortly after clearing the aerodrome parameter fence. The initial impact occurred approximately 500m beyond the end of RWY 11; the aft section of the aircraft struck the ground first, followed by both propellers (the red and blue lines in Figure 9 indicate the propeller strike marks).

1.12.3. The aircraft skidded on the grass for approximately 42m with the retracted landing gear until it impacted the first barrier fence.

Figure 10: The pictures show the damage caused to the barrier fences.

1.12.4. After impact with the first barrier fence, the aircraft became momentarily airborne for approximately 15m before it touched down again.

Figure 11: The space between the barrier fence and the second impact marks.

After touching down on the ground for the second time, the aircraft continued to skid; the left propeller left a prominent furrow on the ground, stretching approximately 181m before the aircraft impacted the second and third barrier fences, as well as the tree across the road (the tree was located 12m from the road).

Figure 12: Impact marks caused by both the fuselage and the right-side propeller.

1.12.5. The aircraft came to rest on its belly between the trees. After the accident, four tyres were placed under the left wing to support and prevent fuel from leaking out from the left-wing tank.

Figure 13: The aircraft as it was found.

The tyres were placed by the pilot and the eyewitness (who was watching the aircraft take-off from near the hangars at the aerodrome) who had rushed to the accident site; this was to prevent fuel from further leaking out of the damaged left wing. Both the left and the right wings sustained damage due to impact with the barrier fences. The right wing sustained damage caused after impact with the barrier fences and the tree.

Figure 14: Damage on both the left and right sides of the propellers and the wings.

1.12.6. The aircraft structure was fairly intact; both wings and the propeller blade had visible damage.

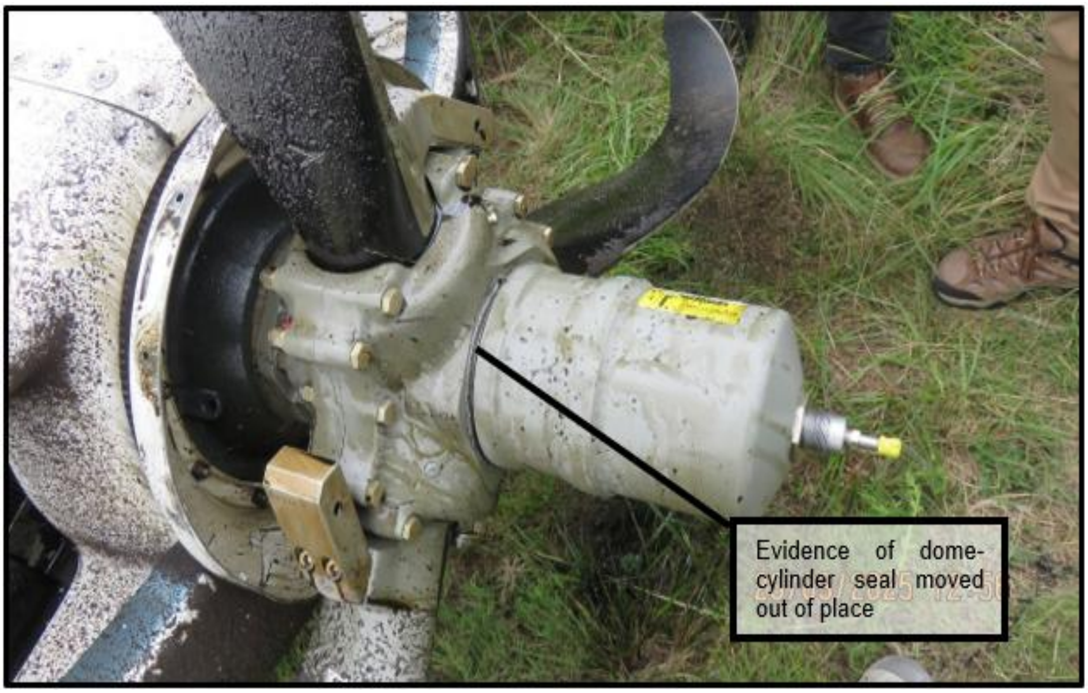


Figure 15: The propeller dome-cylinder mounting was found loose and showed evidence of oil leak.

1.12.7. The propeller's variable pitch mechanism housing dome-cylinder was not properly secured when examined. The oil escaped from it and caused a significant oil loss from the engine and propeller.

1.13. Medical and Pathological Information

1.13.1. Not applicable.

1.14. Fire

1.14.1. There was no pre-or post-impact fire during the accident.

1.15. Survival Aspects

1.15.1. The cockpit and cabin structure had remained intact during the accident. The occupants had used the aircraft safety belts during the flight.

1.16. Tests and Research

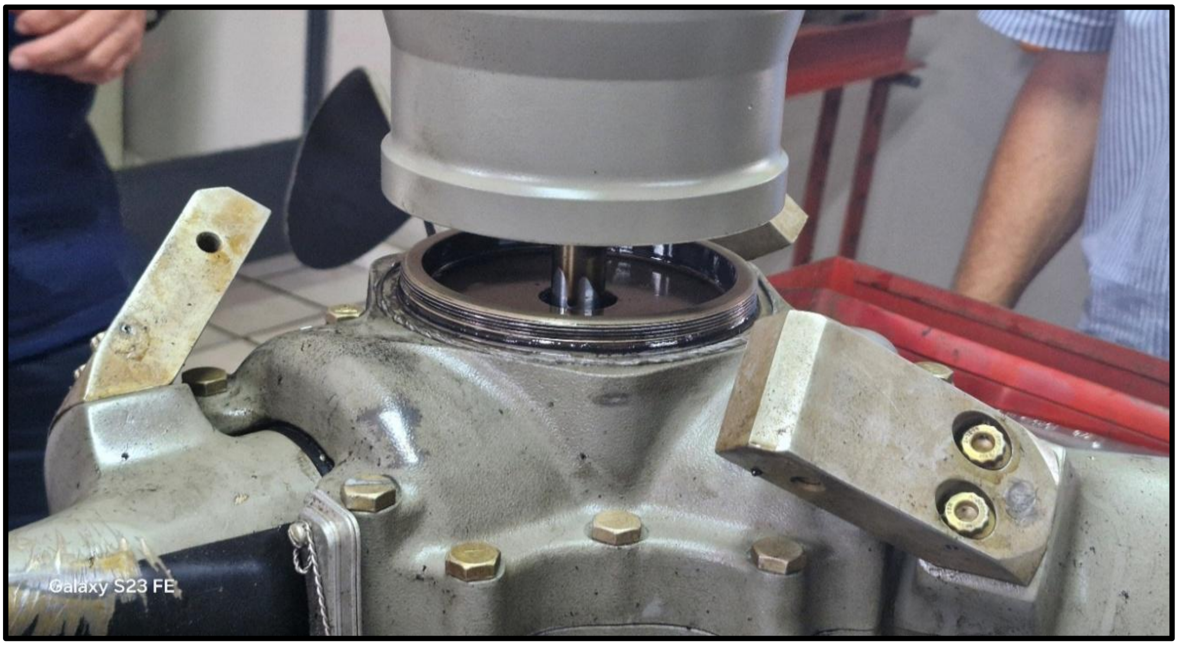


Figure 16: The disassembly of the propeller dome-cylinder.

1.16.1. The on-site investigation determined that the propeller fitted to the No.2 (right side) pitch-changing mechanism housing cylinder had detached from its mounting position, which caused oil to leak. The propeller was disassembled at an approved AMO that specialised in propellers on 26 March 2025. Upon inspection, the ON switch screwing threads were found damaged (See Figure 17). A metallurgical analysis was commissioned to establish the root cause of the failure. The report is attached as Appendix A.

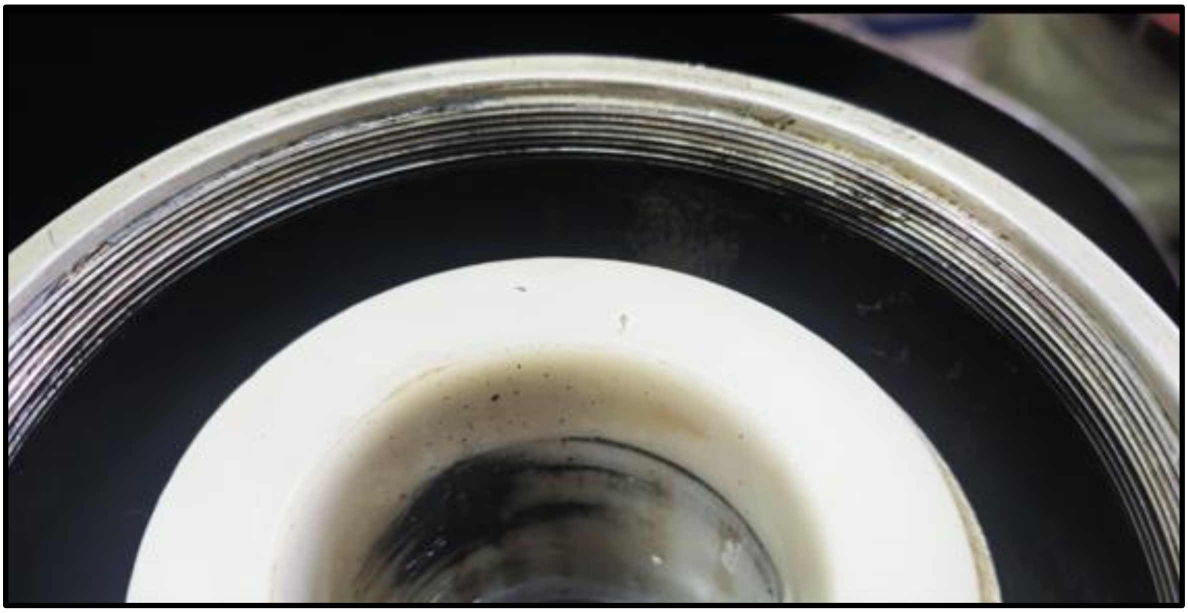


Figure 17: The damaged front threads of the dome-cylinder.

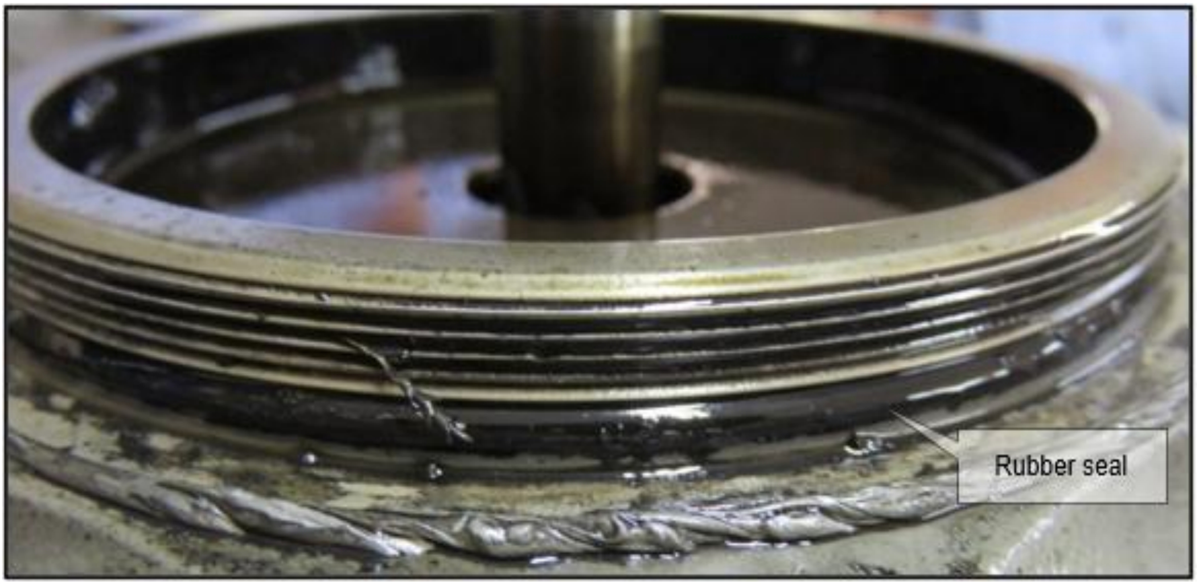


Figure 18: The threads of the intact propeller assembly with the rubber seal in place.

1.16.2. Failure Test Analysis

The propeller components were taken for metallurgical failure analysis. The test and analysis methodology used included visual examination, a stereo microscope and a digital camera. The following details were revealed:

Visual Inspection:

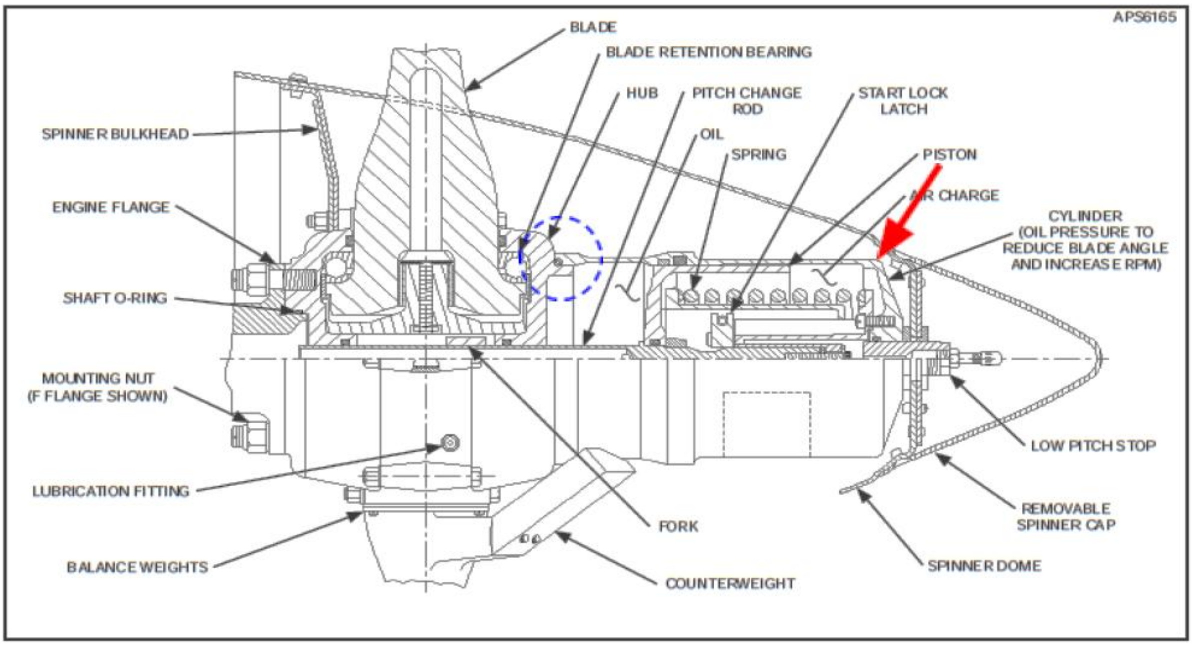


Diagram 1: Schematic cutaway of 2 Series Constant Speed feathering propeller. (Source: IPC)

The on-site visual inspection revealed the right-hand Constant Speed propeller Cylinder (Diagram 1, red arrow) separated from the Hub during operation at the threaded section (blue dashed circle). This is considered the primary cause of the uncommanded propeller blade pitch change, resulting in the reported loss of thrust.

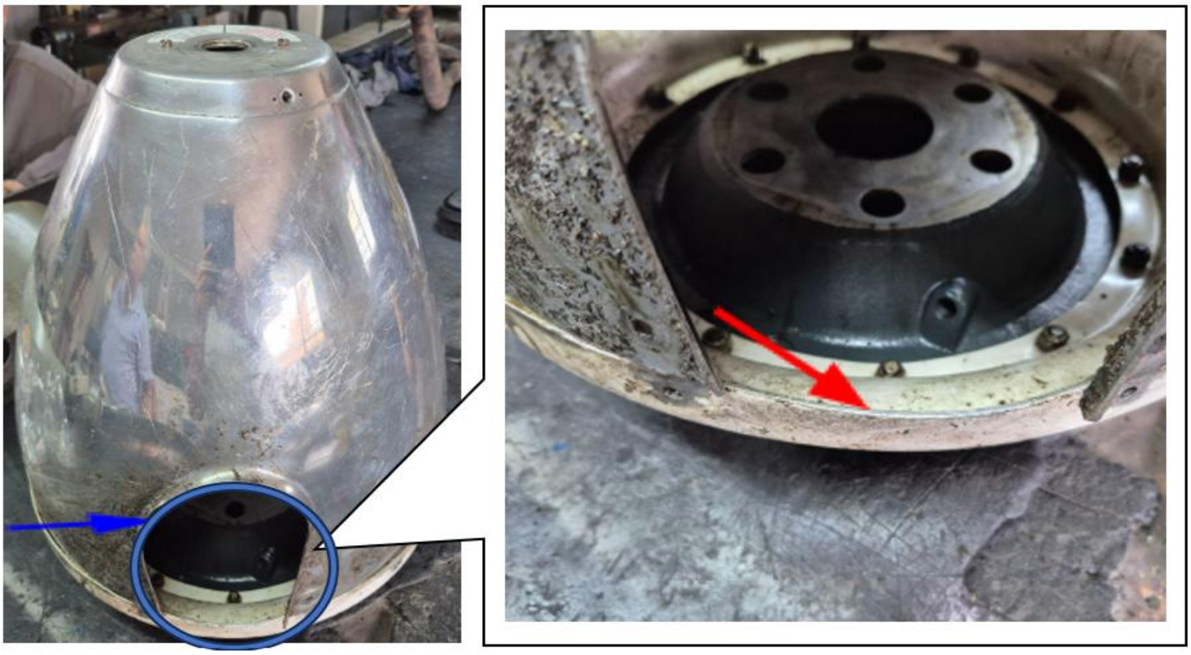


Figure 19: The propeller spinner condition and damage (Photo 4).

Damage to the Spinner Bulkhead (Figure 19, red arrow; Diagram 1) support the separation of the Cylinder from the Hub, allowing the Spinner Dome to move forward. Other noted damage to the Spinner Dome (blue arrow) can be attributed to the impact sequence. Damage at the propeller Blade and Fork interfaces (Figure 20; (Photo 5), red arrow) could be attributed to the forced blade pitch change during the impact sequence. No other damage that was not related to the impact sequence was noted.

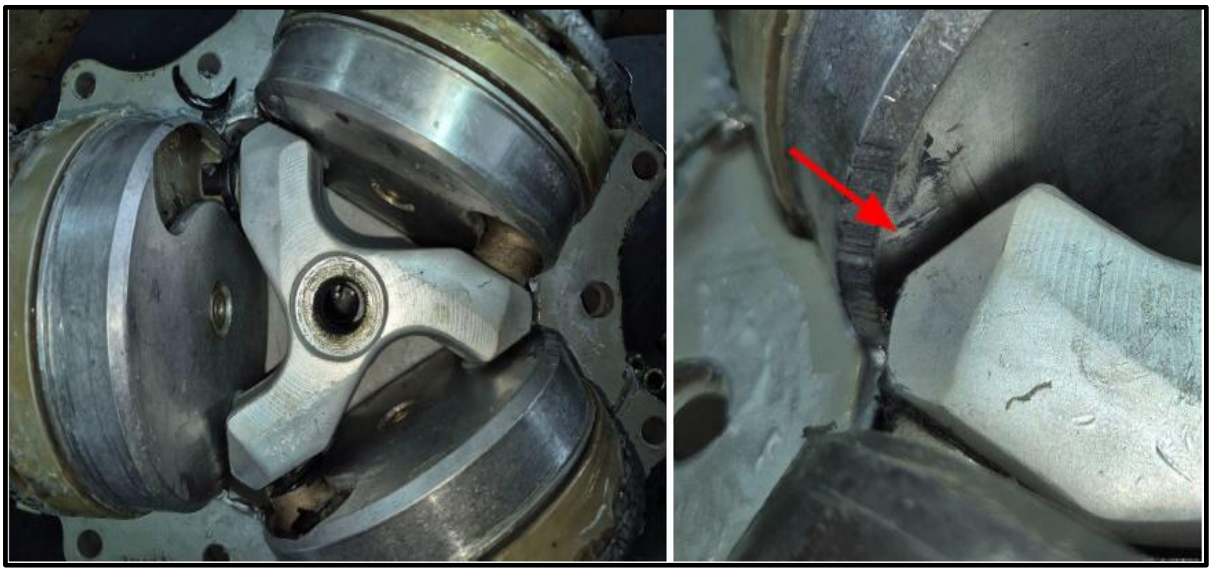


Figure 20: The propeller hub's internal condition and impact marks (Photo 5).

Low- and High-Magnification Inspection Results (Stereomicroscope):

The Cylinder was sectioned to remove the threaded section.

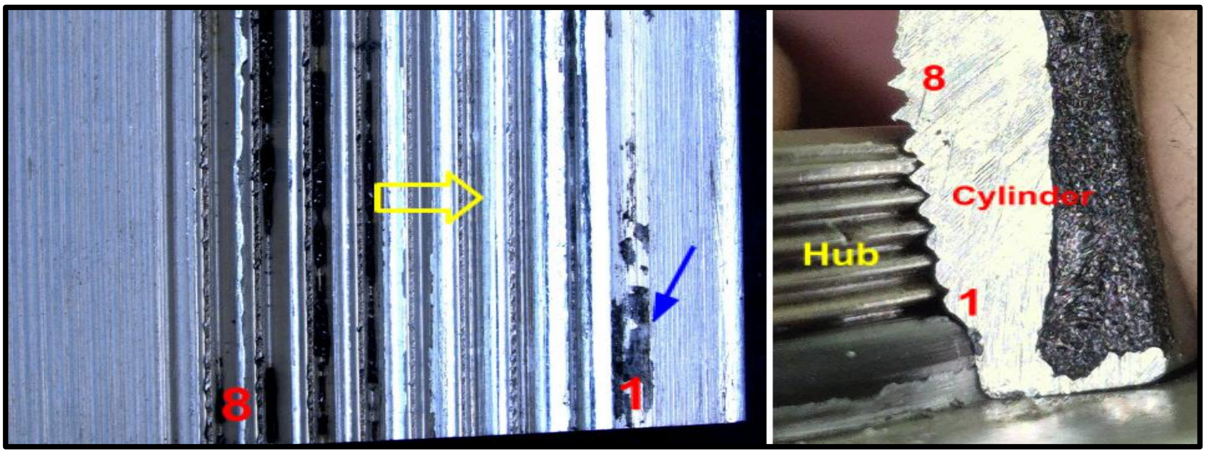


Figure 21: Cylinder threads condition. (Photo 6: stereo/digital)

The Cylinder thread count is 8. However, only 5/6 out of 8 threads are exposed to the applied torque (Figure 21 or photo 6). The direction of the applied torque force onto the threads is towards the bottom (Figures 21, 22 and 23 or Photos 6, 7, and 8, yellow arrows). Remnants of an applied sealant were noted (Photo 6, blue arrow).

A side-view of cylinder threads 1 (bottom) to 6 (Figure 22 or Photo 7) revealed evident and increasing mechanical damage to the thread crests from 1 to 6.

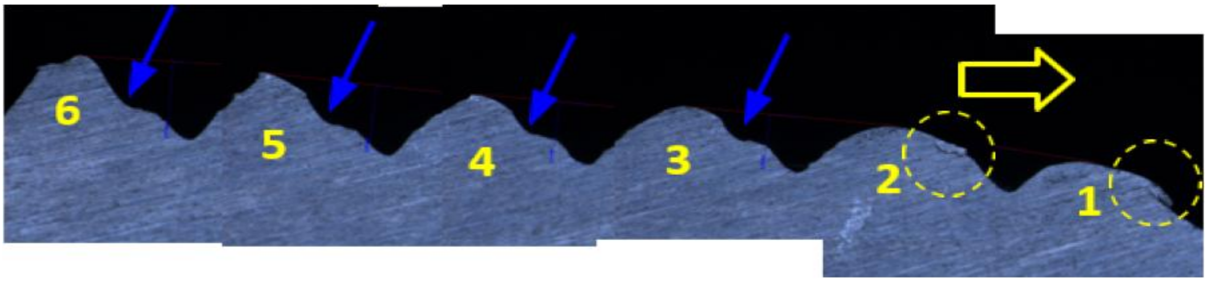


Figure 22: Cylinder threads side view (Photo 7 stereo).

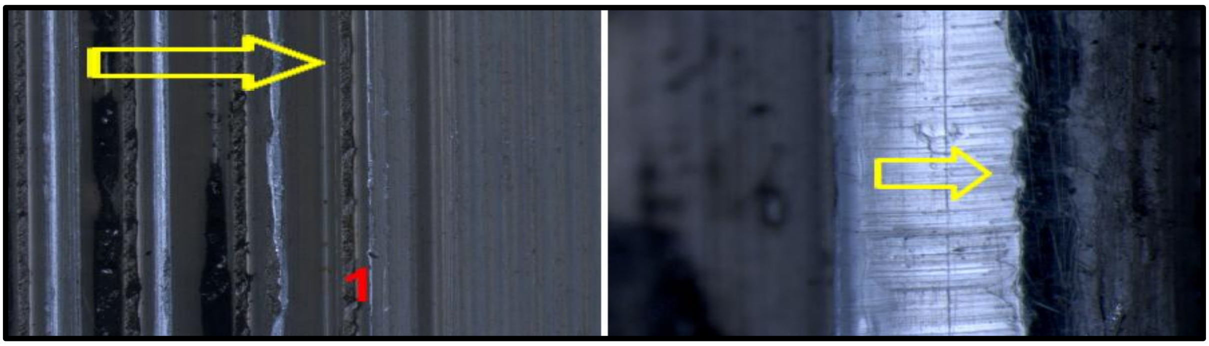
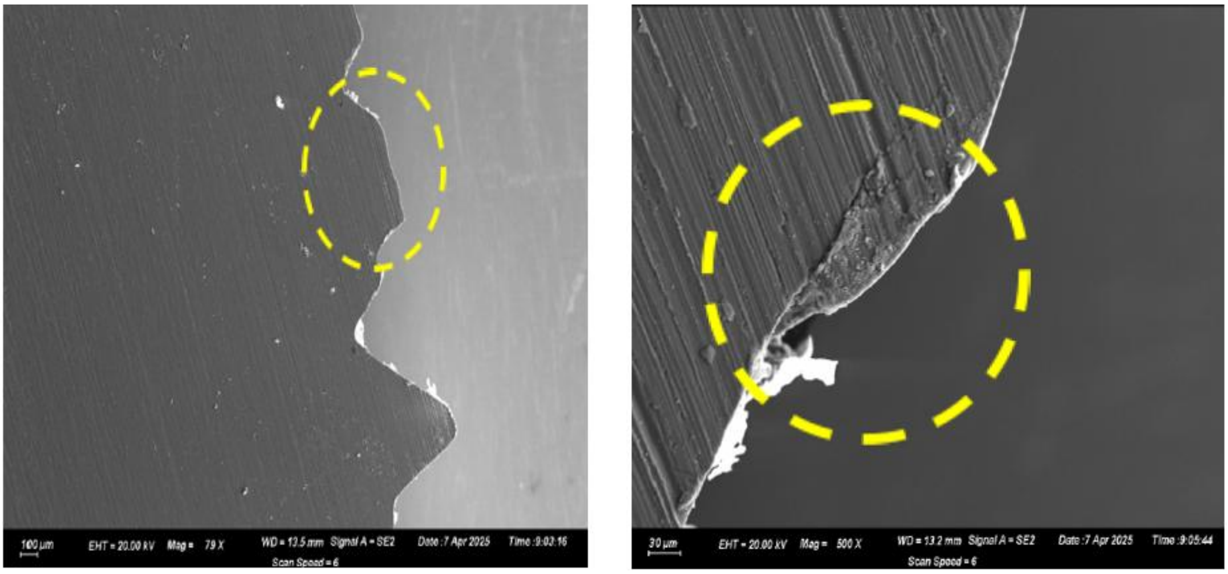


Figure 23: Cylinder thread condition (Photo 8: stereo).

Thread crests 1, 2 and 3 (Figure 22 or Photo 7, yellow dashed circles; Figure 23 or Photo 8) revealed clear indications of slippage (plastic deformation) parallel to the applied torque force (yellow arrow). Higher magnifications confirmed this notion (SEM Images 1 and 2).



SEM Image 1 and 2 show the magnified threads condition.

Circumferential damage to the thread flanks (Figures 22 and 24 or Photos 7 and 9, blue arrows) indicates possible ‘cross-threading’ during fitment.

Figure 24: Cylinder threads condition (Photo 9: stereo).

<u>Other Results</u>

(a) *The Cylinder thread crest/root dimensions revealed a loss of +-75% in thread depth between threads 1 and 8. This indicates extensive mechanical damage (plastic deformation) and is the most probable cause for the noted slippage.*

Figure 25: Governor bench test indicators (Photo 10: digital).

I. *A bench test was performed to determine the serviceability of the pressure relief mechanism from the propeller governor assembly. The results met the Hartzell Original Equipment Manufacturer's (OEM's) requirements with a maximum allowed pressure of 290 pounds per square inch (psi) (Figure 25 or Photo 10).*

Test Conclusion Results

The OEM-specified maintenance and inspection procedures for the Constant Speed Unit (*CSU) assembly were not supplied to the investigator.*

I. *Damages to the cylinder thread area indicated possible 'cross-threading' during fitment, resulting in plastic deformation of the thread crests with a loss in thread depth of +-75%. It could not be conclusively determined if the thread damage was induced during the most recent fitment and/or prior to maintenance.*

II. *The failure and/or the incorrect setting of the governor pressure relief mechanism may lead to over-pressurisation of the cylinder and, thus, possible separation. However, considering the design philosophy that would generally allow for a pressure safety margin, and combined with the test bench results, this probability may be discredited.*

1.17. Organisational and Management Information

1.17.1. The aircraft is privately owned. It was also privately operated on the day of the accident under the provisions of Part 91 of the CAR 2011 as amended.

1.17.2. The AMO that conducted maintenance of the aircraft was issued a Regulator-approved AMO Certificate on 24 April 2024 with an expiry date of 30 April 2025.

1.18. Additional Information

1.18.1. The propeller hub assembly: Diagram 2 of the propeller hub assembly identifies item number 70 as the propeller cylinder. Item number 380 refers to the O-ring used to seal the dome-cylinder. The dome-cylinder houses the propeller pitch-changing mechanism, which includes a spring-loaded piston actuated by engine oil pressure during operation. The installation of the dome-cylinder does not require torque application.

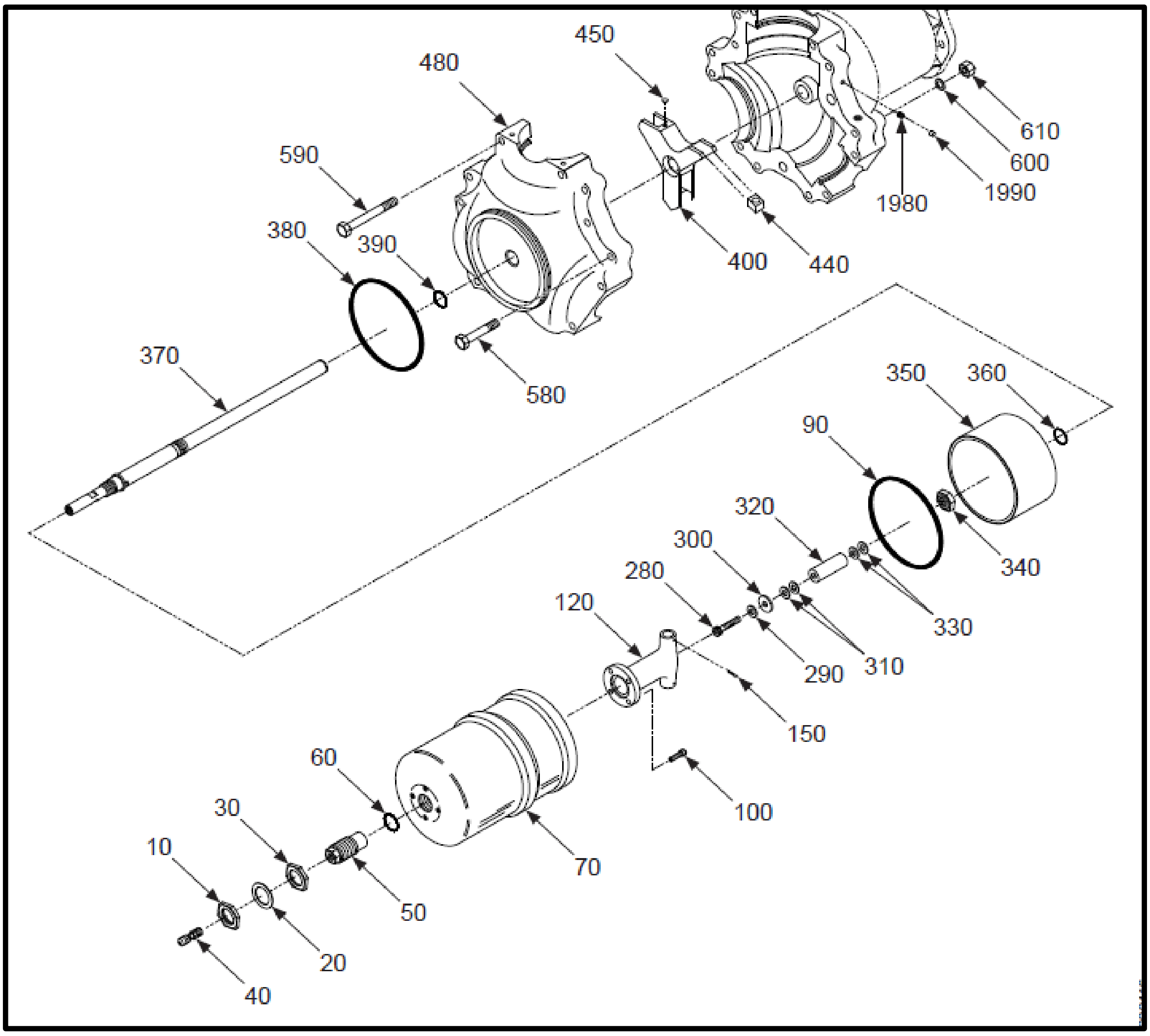


Diagram 2: The schematic diagram of the propeller hub assembly.

1.18.2. Flying Light Twins Safety (Source: FAA-P-8740-66)

Introduction: The major difference between flying a light twin and a single-engine airplane is knowing how to manage the flight if one engine loses power. Safe flight with one engine inoperative (OEI) requires an understanding of the basic aerodynamics involved as well as proficiency in single-engine flight. This booklet deals extensively with the numerous aspects of OEI flight. You must remember, however, not to place undue emphasis on mastery of OEI flight as the sole key to flying light twins safely.

Engine Failure After Lift-off
The manufacturer's recommended procedures for an engine failure shortly after lift-off can be found in the AFM/POH for the specific make and model of airplane. Certain basic procedures, however, are as follows below. Complete failure of an engine after lift-off can be broadly categorized into one of the following three scenarios.

Gear Down
If the failure occurs before selecting the gear to the "up" position, it is recommended that the pilot close both throttles and land on the runway or overrun remaining.

Landing Gear Selected Up, OEI Climb Performance Inadequate

When operating near or above the single-engine ceiling and an engine failure is experienced shortly after lift-off, a landing must be accomplished on essentially whatever lies ahead. The greatest hazard in an OEI take-off is attempting to fly when it is not within the performance capability of the airplane to do so. A recent study revealed a very high success rate for off-airport engine-inoperative landings when the airplane was landed under control. The same study also revealed a very high fatality rate in stall-spin accidents when the pilot attempted flight beyond the performance capability of the airplane.

Landing Gear Selected Up, OEI Climb Performance Adequate

If the single-engine rate of climb performance is sufficient to continue flight, four areas of concern must be addressed. In order of precedence, they include the following:

- *Control. The rudder and aileron should be used aggressively, if necessary, to counteract the yaw and rolling tendencies. At least 5 degrees, and up to 10 degrees, the angle of bank should be used to maintain directional control. The pitch attitude for Vyse should be assumed.*

- *Configure. The actions listed in the "Engine Failure After Take-off" checklist in this pamphlet should be promptly executed to configure the airplane for climb with minimum drag.*

- *Climb. Maintain Vyse. Reduce the bank angle to that of zero sideslip. In the absence of specific AFM/POH recommendations, a bank of approximately 2 to 3 degrees and a ball displacement of about one-half of the ball diameter from the centre should be made. The bank angle and ball displacement will both be toward the operative engine.*

- *Checklist. On reaching 400 feet AGL, refer to the printed checklist. Review the Engine Failure After Take-off Checklist items. If workload permits, then accomplish the "Securing Failed Engine" checklist items to turn off systems and accessories no longer required.*

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 organisation or individual.

2.2. Analysis

2.2.1. The pilot was initially issued a licence by the Regulator on 5 June 2015. He had an Airline Transport Pilot Licence (ATPL) that was issued on 1 July 2024 with an expiry date of 31 May 2025. His Class 1 aviation medical certificate was issued on 14 November 2024 with an expiry date of 30 November 2025.

2.2.2. The pilot had a total of 2116 flight hours of which 234 hours were accumulated on the aircraft type. His licence was endorsed with Night, Instrument and Flight Instructor Grade III ratings. The aircraft type was endorsed on his licence.

2.2.3. The pilot was licensed, qualified and medically fit to conduct the flight.

2.2.4. The aircraft had a Certificate of Airworthiness (C of A) that was issued by the Regulator on 3 September 2024 with an expiry date of 30 September 2025. The aircraft was registered to the current owner on 11 October 1995.

2.2.5. A mandatory periodic inspection (MPI) of the aircraft was conducted and certified on 2 August 2024 at 3616.2 hours after which a Certificate of Release to Service (CRS) was issued with an expiry date of 2 August 2025 or at 3716.2 hours, whichever comes first.

2.2.6. The aircraft maintenance organisation (AMO) responsible for the maintenance of the aircraft had an AMO Certificate that was issued on 24 April 2024 with an expiry date of 30 April 2025.

2.2.7. The aircraft is privately owned. It was privately operated on the day of the accident under the provisions of Part 91 of the CAR 2011 as amended.

2.2.8. Good weather conditions prevailed at the time of the flight; however, the density altitude was significantly high to have an impact on the aircraft's performance, especially with one engine inoperative.

2.2.9. The pitch-changing mechanism housing cylinder on the right engine propeller (engine number 2) loosened from its mounting. This caused the oil to leak which led to a drop in engine oil pressure. As a result, the variable pitch propeller moved to the feathered position, causing the right engine to lose thrust. The pilot attempted a forced landing of the aircraft but it was unsuccessful. An analysis of the failed component showed that the cylinder threads were damaged, likely due to cross-threading during installation. This caused about 75% loss in thread depth. It could not be confirmed whether the damage happened during a recent or an earlier maintenance schedule.

2.2.10. Tests showed that the governor's pressure relief mechanism was working properly and that it was set within Hartzell OEM's limits of 290 psi. This meant that it was adjusted correctly, and there was no indication that it caused unusually high pressure inside the pitch-changing cylinder. The separation of the cylinder during flight must, therefore, be linked to other factors.

2.2.11. Shortly after lift-off, the right engine feathered which led to a significant reduction in performance and a low rate of climb. Whilst the aircraft's weight and balance calculations were within allowable limits, they contributed to the reduced climb capability of the single engine with limited climb performance to clear obstacles. With the aircraft rapidly approaching the end of the runway and aerodrome boundaries, and with the trees and difficult terrain ahead, the pilot quickly assessed that the aircraft would be unable to clear the obstacles. He initiated a forced wheels up (belly) landing on a field near the aerodrome. His prompt decision and execution ensured the survival of all six occupants.

2.2.12. The pilot's decision to perform a belly landing in response to the aircraft's degraded performance and the unsuitable terrain was consistent with the Federal Aviation Administration (FAA) guidance. According to an article published by FAA, "*When operating near or above the single-engine ceiling, and an engine failure occurs shortly after lift-off, a landing must be completed ahead. The greatest hazard after take-off is attempting to fly when it is not within the performance capability of the airplane to do so.*" The pilot's actions aligned with this principle of prioritising a survivable landing over attempting continued flight beyond the aircraft's capabilities.

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 pilot was initially issued a licence by the Regulator on 5 June 2015. He had an Airline Transport Pilot Licence (ATPL) that was issued on 1 July 2024 with an expiry date of 31 May 2025. His Class 1 aviation medical certificate was issued on 14 November 2024 with an expiry date of 30 November 2025.

3.2.2. The pilot had a total of 2116 flight hours of which 234 hours were accumulated on the aircraft type. His licence was endorsed with Night, Instrument and Flight Instructor Grade III ratings. The aircraft type was endorsed on his licence.

3.2.3. The pilot was licensed, qualified and medically fit to conduct the flight.

3.2.4. The aircraft had a Certificate of Airworthiness (C of A) that was issued by the Regulator on 3 September 2024 with an expiry date of 30 September 2025. The aircraft was registered to the current owner on 11 October 1995.

3.2.5. A mandatory periodic inspection (MPI) of the aircraft was conducted and certified on 2 August 2024 at 3616.2 hours after which a Certificate of Release to Service (CRS) was issued with an expiry date of 2 August 2025 or at 3716.2 hours, whichever comes first.

3.2.6. The aircraft maintenance organisation (AMO) responsible for the maintenance of the aircraft had an AMO Certificate that was issued on 24 April 2024 with an expiry date of 30 April 2025.

3.2.7. The aircraft is privately owned. It was privately operated on the day of the accident under the provisions of Part 91 of the CAR 2011 as amended.

3.2.8. The pitch-changing mechanism housing cylinder on the right engine propeller (engine number 2) loosened from its mounting. This caused an oil leak, which led to a decay in engine oil pressure. As a result, the variable pitch propeller moved to the feathered position, causing the right engine to lose thrust.

3.2.9. An analysis of the failed component showed that the cylinder threads were damaged, likely due to cross-threading during installation. This caused about 75% loss in thread depth. It could not be confirmed whether the damage happened during a recent or an earlier maintenance schedule.

3.2.10. The propeller governor's pressure relief mechanism functioned within the OEM's specifications. It was correctly set and there was no evidence that it created excessive pressure or contributed to the cylinder separating in-flight.

3.2.11. Although the weight and balance calculations were within the limits, they, were a contributing factor following performance degradation due to one of the engines' operations and which resulted from the number two engine's constant speed propeller pitch change failure.

3.2.12. Following the right engine auto-feather shortly after take-off, the aircraft experienced reduced performance. Recognising the inability to clear obstacles ahead, the pilot made a timely decision to perform a belly landing on a nearby field which resulted in the survival of all six occupants.

3.2.13. The pilot's decision to execute a belly landing due to degraded performance and unsuitable terrain aligned with FAA guidance which recommends landing immediately when an engine fails after take-off and if the aircraft's single-engine capability is unlikely to sustain a safe flight.

3.2.14. The aircraft was 144lbs (65kg) below its maximum take-off weight for the return flight to FAWB, which had a significant effect on the climb performance with a single engine being operative.

3.2.15. Although fine weather conditions prevailed, the density altitude was calculated to be 7 195 ft, which would have had a direct effect in reducing engine performance, especially with one engine inoperative during the initial climb.

3.3. Probable Cause/s

3.3.1. The pilot conducted an unsuccessful forced landing after the aircraft lost thrust from the right-side engine. The loss of thrust was a result of the propeller that auto-feathered because of low engine oil pressure which was caused by the propeller pitch-change cylinder loosening due to damaged threads.

3.4. Contributory Factors

3.4.1. Improper fitment of the propeller hub during maintenance installation.

3.4.2. The aircraft was close to its maximum allowable weight which, along with high-density altitude, reduced engine performance and climb ability on one of the engines.

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 Recommendations

4.2.1. None.

5. APPENDICES

5.1. Appendix A: Failure Analysis of the Propeller Constant Speed Unit assembly

This report is issued by:

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

5.1. Annexure A: Failure Analysis of the Propeller Constant Speed Unit assembly

COMPILED BY	F.A.I.L.	PAGE 2 OF 13	
COMPILED FOR: AAS (Pty) Ltd	**INVESTIGATION REPORT:** AEROSTAR 600A CSU FAILURE, AIRCRAFT NO ZS-NJD	DOCUMENT NUMBER **FA-014-04-25**	
		DATE **2025-04-10**	ISSUE **1**

1. INTRODUCTION & BACKGROUND INFORMATION

1.1. Tasking Information:

The right-hand Constant Speed Unit and Propeller assembly (Photo 2) from an Aerostar 600 aircraft, registration ZS-NJD (Photo 1), was submitted to determine the most probable contributing factors to the failure during operation.

1.2. Background Information

1.2.1. Pilot's Incident Report:[1]

Shortly after take-off, the pilot retracted the undercarriage and reduced the flap setting from 20 to 15, at which point he noticed a decrease in airspeed. He turned left and aimed for an open plowed field just beyond the end of Runway 11. The aircraft lost airspeed, and the pilot executed an emergency landing in the plowed field with the undercarriage retracted before the airspeed reached the minimum control speed of 84 knots.

1.2.2. Initial Assessment (Assessor):

As the aircraft took off, the right propeller feathered due to the unseating of the propeller dome from the hub, leading to a loss of dome oil pressure.

The right propeller entered a feathered state shortly after take-off, merely 53 hours following a midlife inspection. This issue was attributed to the dome becoming unseated from the propeller hub.

Potential causes for the failure include damage to the propeller hub threads during assembly after the recent midlife inspection or a malfunction of the Constant Speed Unit (CSU) pressure relief valve, leading to excessive oil pressure in the dome. However, this latter possibility is deemed unlikely, as the propeller cycled normally during the engine run-up. The CSU regulates engine oil pressure to the propeller dome within the range of 260 to 290 PSI to manage the pitch of the propeller blades.

1.2.3. Component and Aircraft Maintenance History:

The logbooks reflect the following information:

Next Inspection due :	3 716.2 hours
Hours flown since last MPI :	29.5 hours
Airframe hours flown at time of accident :	3 645.7hours
Left engine hours flown since overhaul on 10/01/2001:	1,711.1 hours
Right engine hours flown since overhaul on 10/02/2001:	1,711.1 hours

[1] Courtesy AAS cc

Left propeller hours since midlife : 53.3 hours
Right propeller hours since midlife : 53.3 hours

The aircraft was within its 100-hour / annual inspection period. The engine has a TBO of 2,000 hours or 12 years. The propeller has a TBO of 2,200 hours or 6 years.

At the last MPI, both engines were inspected in terms of CATS 43.02.5 for continued service beyond their calendar TBO of 12 years.

The propellers have a calendar life of 6 years; however, in South Africa, a midlife inspection can be carried out at 5 years in terms of CARS 44, which extends the calendar life to 10 years under specific conditions.

Photo 1: Aerostar 600, ZS-NJD[2]

Photo 2: RH CSU assembly, as found (digital)

1.2. This report is divided into the following sections:

(a) INTRODUCTION Par. 1
(b) APPLICABLE DOCUMENTS Par. 2
(c) DEFINITIONS Par. 3
(d) INVESTIGATOR Par. 4
(e) APPARATUS AND METHODOLOGY Par. 5
(f) INVESTIGATION Par. 6
(g) DISCUSSION AND CONCLUSIONS Par. 7
(h) RECOMMENDATIONS Par. 8
(i) DECLARATION Par. 9

[2] Courtesy Airfleets.net

2. APPLICABLE DOCUMENTS

(a) AAS Preliminary Survey Report (Confidential).
(b) Historic maintenance information.[3]
(c) Hartzell Governor Overhaul Manual 130B.
(d) Propeller Owner's Manual 115N.

3. DEFINITIONS

AAI	Aircraft Accident Investigation	MPI	Mandatory Parts Inspection
AC	Advisory Circular	NDE	Non-Destructive Evaluation
AD	Airworthiness Directive	NDI	Non-Destructive Inspection
AISI	American Iron and Steel Institute	NDT	Non-Destructive Testing
AME	Aircraft Maintenance Engineer	NLG	Nose Landing Gear
AMO	Aircraft Maintenance Organization	OEM	Original Equipment Manufacturer
ASI	Air-Speed Indication/or	OHSA	Occupational Health and Safety Act
ASTM	American Society for Testing and Materials	POD	Probability of Detection
BE	Big End	QMS	Quality Management System
DPI	Dye-Penetrant Inspection	RC	Rockwell C-scale
EBSD	Electron Back-Scatter Diffraction	RH	Right-Hand
ECSA	Engineering Council of SA	RoD	Rate of Descent
EDS	Energy-Dispersive X-ray Spectroscopy	RT	Radiographic Testing
FAA	Federal Aviation Authority	SABS	South African Bureau of Standards
FOD	Foreign Object Damage	SACAA	South African Civil Aviation Authority
HE	Hydrogen Embrittlement	SB	Service Bulletin
HIC	Hydrogen Induced Cracking	SCC	Stress Corrosion Cracking
HSS	High-Strength Steels	SE	Small End
ICAO	International Civil Aviation Authority	SEM	Scanning Electron Microscope
IG	Inter-Granular	TBO	Time Before Overhaul
IR	Infra-red or Thermal Testing	TG	Trans-Granular
LH	Left-Hand	TSO	Time Since Overhaul
MAUW	Maximum All-Up Weight	TTSN	Total Time Since New
MLG	Main Landing Gear	UT	Ultrasonic Testing
MPI	Magnetic Particle Inspection	VSI	Vertical Speed Indicator

4. PERSONNEL

[3] Courtesy Breytech Aviation

(a) This report's investigative member and compiler is Mr C.J.C. Snyman. Mr. Snyman is a qualified Physical Metallurgist (ECSA Registration: Prof. Eng. Tech. No 201670194 Metallurgical Engineering; Radiation Protection Officer (RPO, NNR, No 281); Aircraft Accident Investigator.

5. APPARATUS AND METHODOLOGY

(a) A Stereo-Microscope and a Digital Camera are employed for this investigation.
(b) The methodology included visually examining supplied parts and a light– and scanning-electron microscope investigation.
(c) Apparatus:

Type	Make/Model	Operator
Stereo-Microscope	Zeiss Discover V20	C.J.C. Snyman
Scanning Electron Microscope	Zeiss 540 Crossbeam FEGSEM	C.J.C. Snyman
EDS	Oxford Aztec	C.J.C. Snyman

6. INVESTIGATION

Note 1: *Only the supplied part/s were considered for this investigation.*

6.1. Visual- and Low-Magnification Inspection (Propeller Assembly, Diagram 1):

6.1.1. Visual on-site Inspection results:

The on-site visual inspection revealed the right-hand Constant Speed propeller Cylinder (Diagram 1, red arrow) separated from the Hub during operation at the threaded section (blue dashed circle). *This is considered the primary cause of the uncommanded propeller blade pitch change, resulting in the reported loss of thrust.*

Damages to the Spinner Bulkhead (Photo 4, red arrow; Diagram 1) support the separation of the Cylinder from the Hub, allowing the Spinner Dome to move forward. Other noted damages to the Spinner Dome (blue arrow) can be attributed to the impact sequence.

Damages at the propeller Blade and Fork interfaces (Photo 5, red arrow) can be attributed to the forced blade pitch change during the impact sequence.

No other damages not related to the impact sequence were noted.

6.1.2. Low- and High-Magnification Inspection Results:

The Cylinder was sectioned to remove the threaded section.

The Cylinder thread count is 8. However, only 5/6 out of 8 threads are exposed to the applied torque (Photo 6). The direction of the applied torque force onto the threads is towards the bottom (Photos 6, 7, and 8, yellow arrows). Remnants of an applied sealant were noted (Photo 6, blue arrow).

A side-view of Cylinder threads 1 (bottom) to 6 (Photo 7) revealed evident and increasing mechanical damage to the thread crests from 1 to 6.

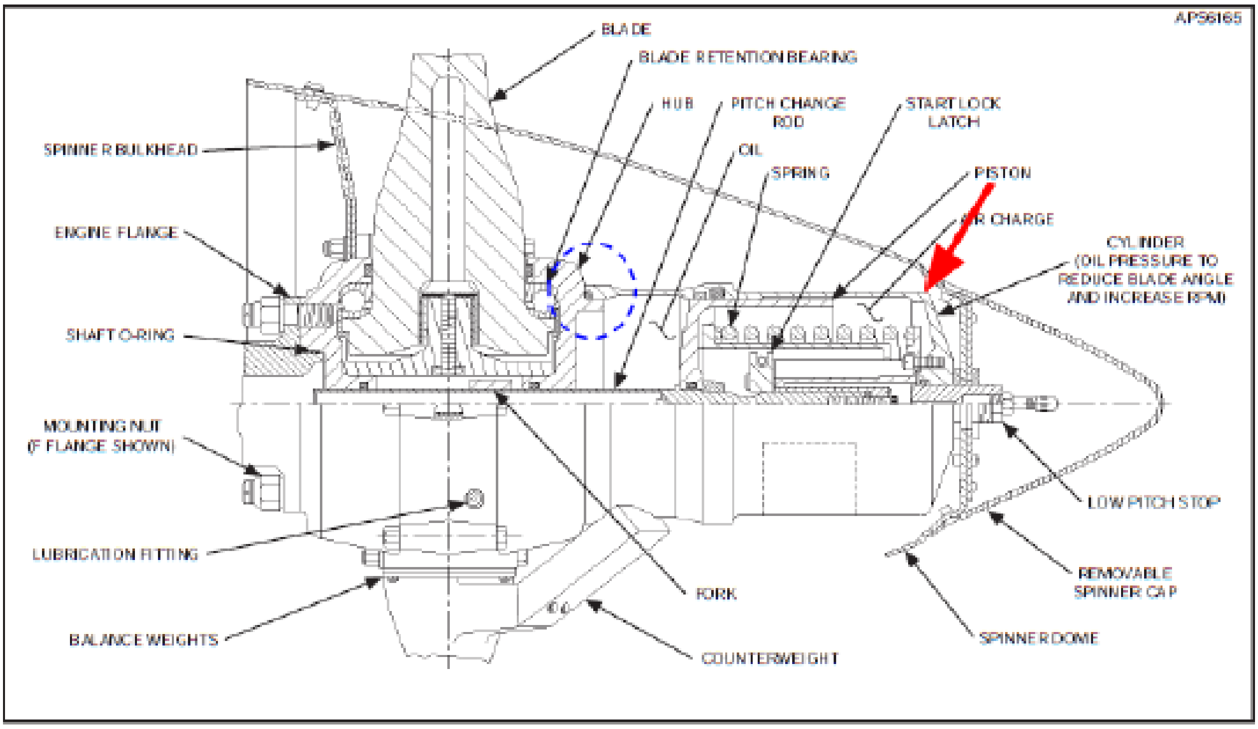
Thread crests 1, 2, and 3 (Photo 7, yellow dashed circles; Photo 8) revealed clear indications of slippage (plastic deformation) parallel to the applied torque force (yellow arrow). Higher magnifications confirmed this notion (SEM Images 1 and 2).

Circumferential damages to the thread flanks (Photos 7 and 9, blue arrows) indicate possible 'cross-threading' during fitment.

6.1.3. Other results:

(a) The Cylinder thread crest/root dimensions revealed a loss of +-75% in thread depth between threads 1 and 8. This indicates extensive mechanical damage (plastic deformation) and is the most probable cause for the noted slippage.

(b) A bench test was performed to determine the serviceability of the pressure relief mechanism from the propeller governor assembly. The results met the McCaulley (OEM) requirements with a maximum allowed pressure of 290psi (Photo 10).



Cutaway of -2 Series Constant Speed, Feathering Propeller ( )HC-( )( )Y( )-2
Figure 2-2

Diagram 1: Propeller Assembly[4]

Photo 3: Cylinder, removed (digital)

Photo 4: Spinner condition and damages (digital)

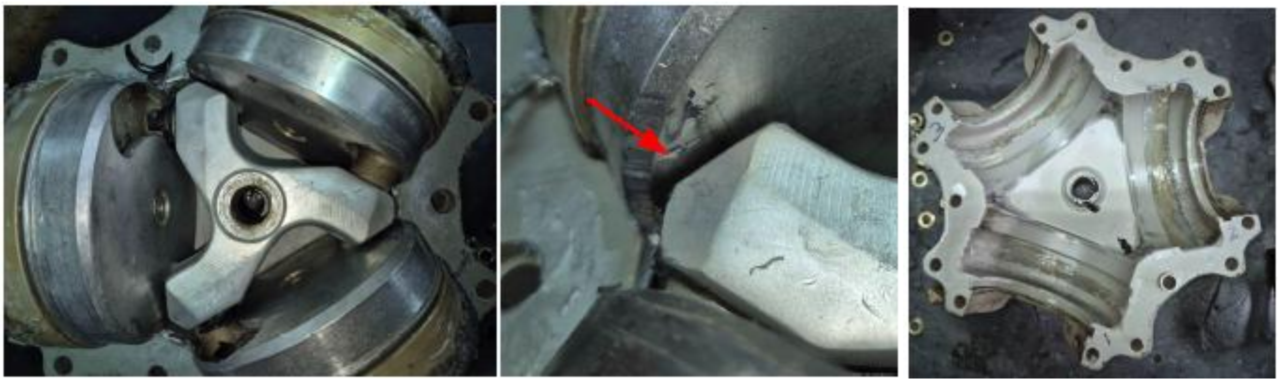


Photo 5: Hub internal condition and impact marks (digital)

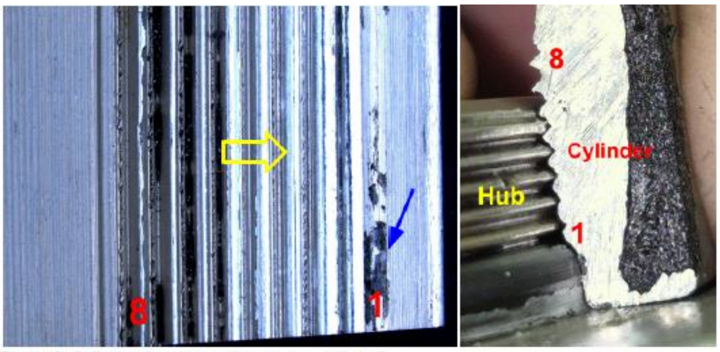


Photo 6: Cylinder thread condition (stereo/digital)

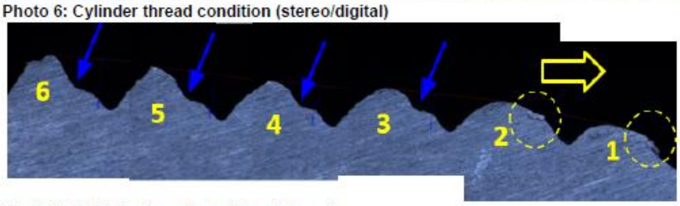


Photo 7: Cylinder thread condition (stereo)

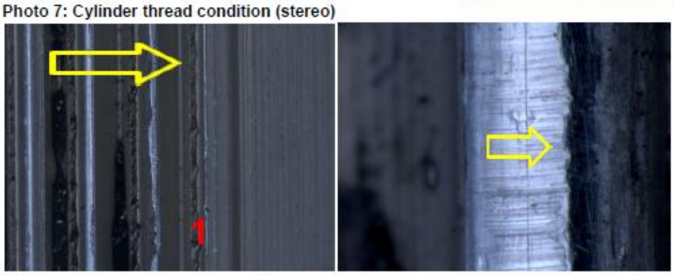
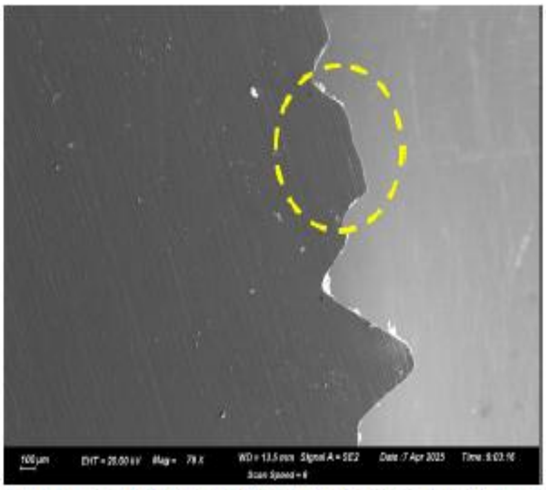


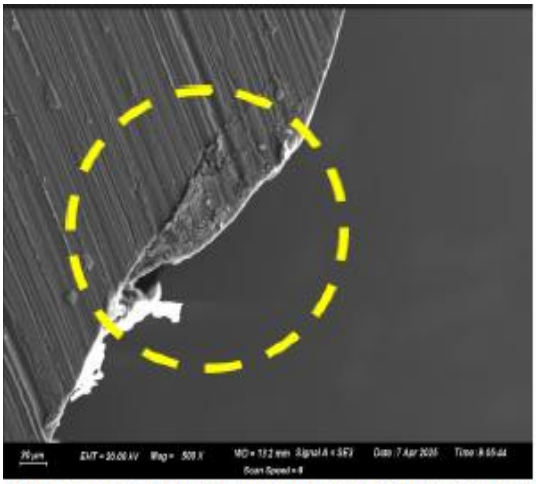
Photo 8: Cylinder thread condition (stereo)

Photo 9: Cylinder thread condition (stereo)

Photo 10: Governor bench test indicators (digital)



SEM Image 1: Cylinder thread condition (FEGSEM, 20kV, SE)



SEM Image 2: Cylinder thread condition (FEGSEM, 20kV, SE)

7. DISCUSSION AND CONCLUSIONS

<u>Note 3:</u> *The <u>conclusions</u> are based on the investigation results obtained from the supplied parts/components only.*

<u>Note 4:</u> *All information supplied to this investigation is deemed to be factual.*

7.1. Inspection Results:

The investigation results support the hypothesis that the cylinder separated from the propeller assembly during operation.

7.2. Probable Contributing Factors:

Note 5: The OEM-specified maintenance and inspection procedures for the CSU assembly were not supplied to this investigation.

(a) Damages to the cylinder thread area indicate possible '*cross-threading*' during fitment, resulting in plastic deformation of the thread crests with a loss in thread depth of +-75%. *It could not be conclusively determined if the thread damages were induced during the most recent fitment and/or prior maintenance.*

(b) The failure and/or the incorrect setting of the governor pressure relief mechanism may lead to overpressurization of the cylinder and thus possible separation. However, considering the design philosophy that would generally allow for a pressure safety margin, and combined with the test bench results, this probability may be discredited.

8. RECOMMENDATIONS

8.1. AMO:

It is recommended that the AMO diligently follow all OEM inspections and fitment requirements. Furthermore, inspection of the cylinder thread for damage is highly recommended before fitment.

8.2. Operator:

None applicable.

8.3. OEM:

None applicable.

9. DECLARATION

9.1. The author has acquired all digital images and displayed them un-tampered.