SOUTH AFRICAN CIVIL AVIATION AUTHORITY

*Section/division* **Accident and Incident Investigations Division** Form Number: CA 12-57

# LIMITED OCCURRENCE INVESTIGATION REPORT – FINAL

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|---|---|---|---|---|---|---|---|
| **Reference Number** | CA18/3/2/1419 | | | | | | |
| **Classification** | Serious Incident | **Date** | 30 June 2023 | | **Time** | 1830Z | |
| **Type of Operation** | Training (Part 141) | | | | | | |
| **Location** | | | | | | | |
| Place of Departure | Chief Dawid Stuurman International Airport (FAPE), Eastern Cape Province | Place of Intended Landing | Chief Dawid Stuurman International Airport (FAPE), Eastern Cape Province | | | | |
| Place of Occurrence | On Runway 34 at Grahamstown Airport (FAGT), Eastern Cape Province | | | | | | |
| GPS Co-ordinates | Latitude | 33º 17'16.39"S | Longitude | 26º30'07.08"E | | Elevation | 2 111 ft |
| **Aircraft Information** | | | | | | | |
| Registration | ZS-OVY | | | | | | |
| Make; Model; S/N | Piper Aircraft Corp; PA28-161 (Warrior III) (Serial Number: 2842156) | | | | | | |
| Damage to Aircraft | Substantial | | Total Aircraft Hours | 11 695.3 | | | |
| **Pilot-in-command** | | | | | | | |
| Licence Type | Commercial Pilot Licence (CPL) | | Gender | Male | | Age | 28 |
| Licence Valid | Yes | Total Hours | 654.8 | Total Hours on Type | | 554 | |
| Total Hours 30 Days | 6.8 | | Total Flying on Type Past 90 Days | 97.8 | | | |
| **People On-board** | 2+0 | **Injuries** | 0 | **Fatalities** | 0 | **Other (on ground)** | 0 |

**What Happened**

On Friday, 30 June 2023, an instructor and a student pilot on-board a Piper PA28-161 aircraft with registration ZS-OVY took off on a night navigation training flight from Chief Dawid Stuurman International Airport (FAPE) in the Eastern Cape province, with the intention to land at the same airport. The flight was conducted under the provisions of Part 141 of the Civil Aviation Regulations (CAR) 2011 as amended.

The flight instructor reported that whilst overhead the northern suburbs of Grahamstown and climbing past 4200 altitude (+-2000) above ground level (AGL), they heard a loud bang in the cockpit which was followed by a drastic drop in engine revolutions per minute (rpm) and the vibration of the airframe. The instructor took the control of the aircraft. With the Grahamstown Airport (FAGT) Runway 34 to his right and in sight, he positioned the aircraft for a forced landing. The aircraft came to a stop safely on the centreline approximately three quarters down Runway 34. No persons were injured during the incident. The aircraft was also not damaged.

Post-incident, the instructor opened the engine cowlings and noticed that the left cylinder head was damaged, and the oil was dripping to the floor. The aircraft was pushed from Runway 34 to the apron where it was secured.


**Figure 1:** The FAGT layout. (Source: Google Earth)

The aircraft maintenance organisation (AMO) conducted an examination of the cylinder number 2 after the incident.

The technical report from the AMO established the following:
Engine: Lycoming

*Cylinder number 2 had complete separation between the cylinder (steel) and head section (aluminium). The engine cylinders and heads are screwed and shrunk together, the cause of separation between this cylinder and head was the head material cracking and eventually causing the head to break off. There are signs of an initial crack indicated by blowby residue from the combustion gases escaping through a section about one quarter of the circumference of the cylinder barrel. The cause of the crack is unknown, however, the manufacturer of the cylinder assemblies had trouble with similar occurrences with their products in the past. Please refer FAA AD2007-04-19R1 as well as Superior Air Parts SB 0601. The engine oil sump was drained and a total of 1.2 Liters was measured.*

*Damage caused by the cylinder assembly failure:*
*The investigation revealed slight damage to the engine cowling due to impact from the cylinder head coming off, this is mostly paint related. Loss of oil due to the pushrod shrouds that were pulled out of place. Slight damage to the exhaust riser.*

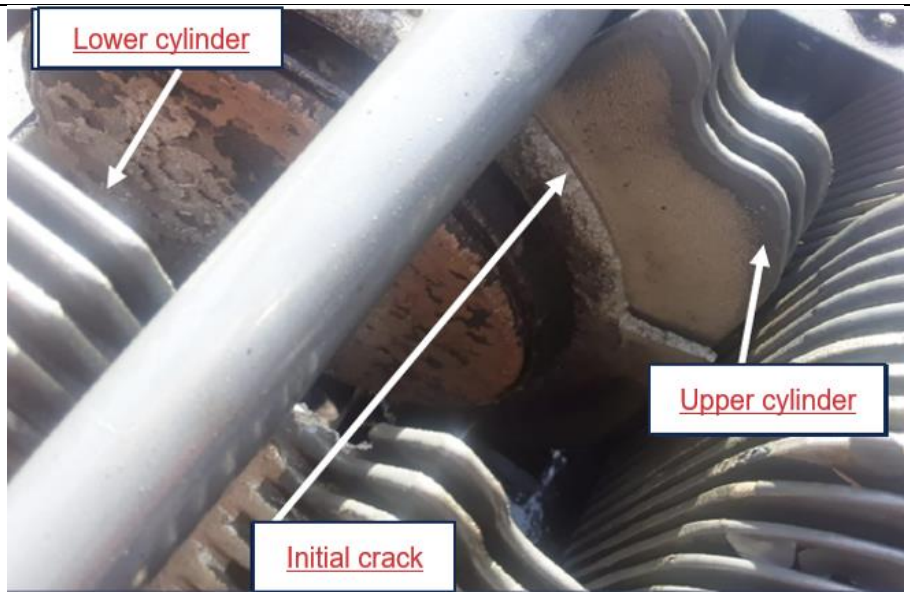


**Figure 2:** The separated cylinders. (Source: Operator)

**Figure 3:** The upper part of the cylinder. (Source: Operator)

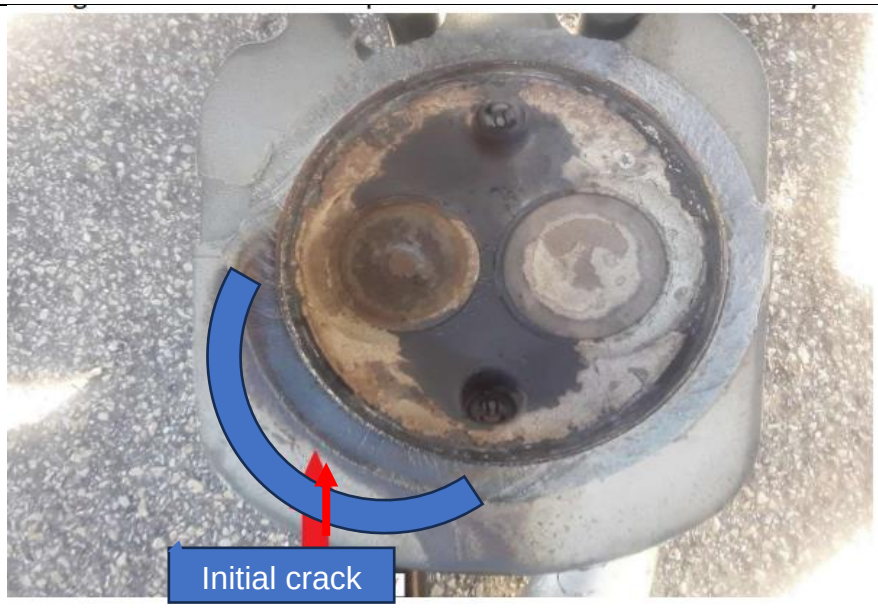


**Figure 4:** The bottom part of the cylinder. (Source: Operator)

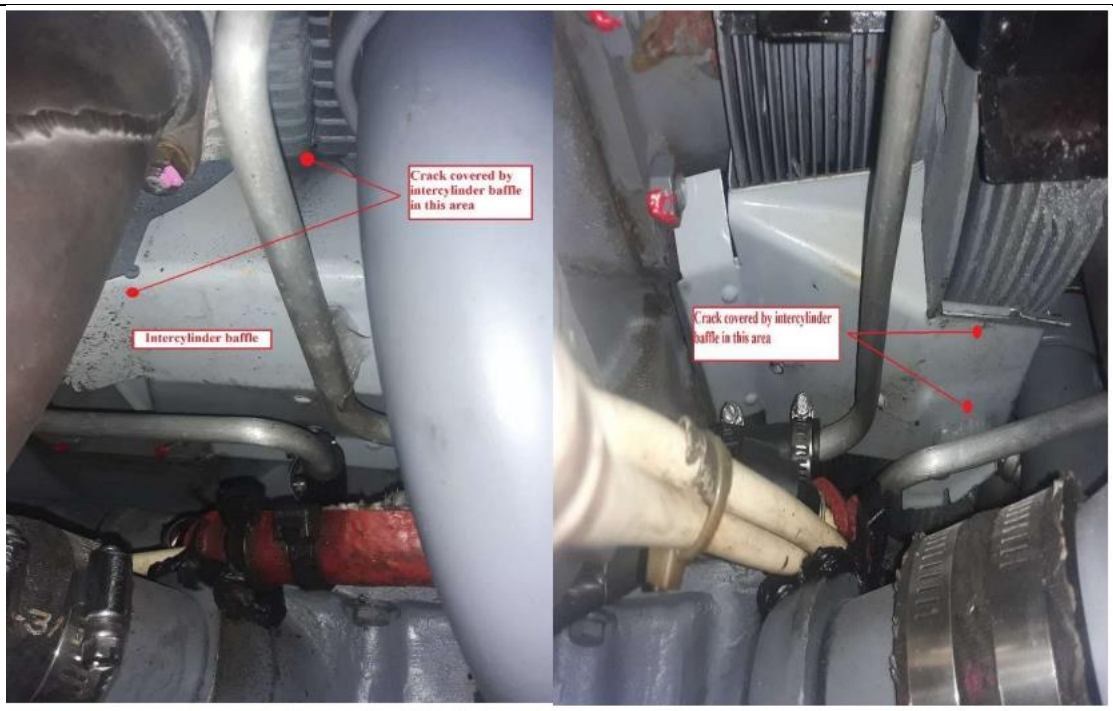


**Figure 5**: The location of the cracks covered by the baffles. (Source: Operator)

*The location of the crack and the fact that it was covered by the baffles would have made it difficult to find. The aircraft was maintained in accordance with Piper Maintenance Manual Part number761-882 Rev 8/31/2019 and GMRs. The aircraft had flown 11.5 airframe hours since the last annual inspection that was carried out on 4 June 2023 and a compression test (blowby test) (testing for air leakage) showed good compressions on all 4 cylinders. Since engine overhaul the aircraft had flown 1504.3 airframe hours. The time between overhaul (TBO) is 2200 engine hours.*

*Conclusion:*

*The engine malfunctioned due to power loss caused by a cylinder head failure due to the fatigue crack. The crack started in an area located between the cylinders on the lower side that is covered by inter cylinder baffles. The compression test showed good results. The cylinder fatigue crack is similar to those failures that were recalled by the manufacturer,*

Piper Maintenance Manual Part number761-882 Rev 8/31/2019 states:
Annual Inspection Requirements:
Each annual inspection must include the following inspection procedures which will help identify internal or external structural discrepancies developing or present in the cylinder assembly. They consist of:
(a) visual inspection
(b) compression check
(c) leak check

Magnetic Particle and Fluorescent Penetrant Inspection:

Power Stroke Stress Area of the Cylinder Barrel (see Figure 6)

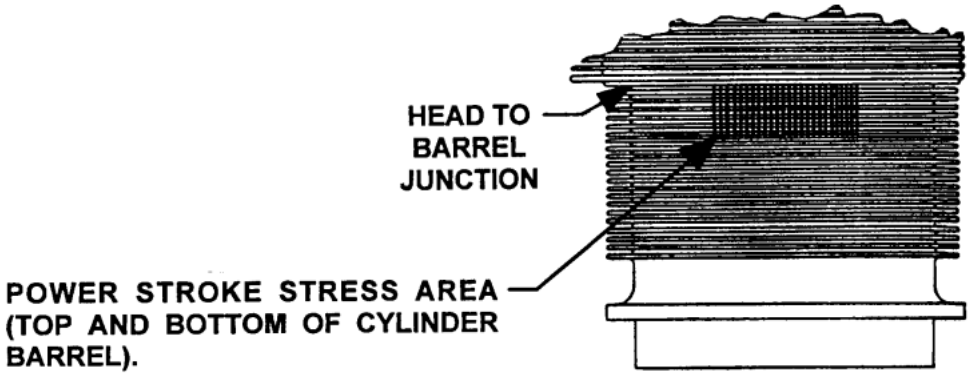


**Figure 6:** The cylinder barrel. (Source: SB96-12)

The Airworthiness Directive (AD 2009-26-12)

(Source: Manufacturer)

Summary:

*The FAA is superseding an existing airworthiness directive (AD) for Lycoming Engines (formerly Textron Lycoming) models 320, 360, and 540 series, ‘‘Parallel Valve" reciprocating engines, with certain Engine Components, Inc. (ECi) cylinder assemblies, part number (P/N) AEL65102 series ‘‘Titan," installed. That AD currently requires initial and repetitive visual inspections and compression tests to detect cracks at the head-to-barrel interface, replacement of cylinder assemblies found cracked, and replacement of certain cylinder assemblies at new, reduced times-in-service. This AD requires the same actions, but for an expanded population of cylinder assemblies. This AD results from reports of 10 additional cylinder head separations since issuing AD 2008-19-05, on cylinder serial numbers not listed in that AD. We are issuing this AD to prevent loss of engine power due to cracks at the head-to-barrel interface and possible engine failure caused by separation of a cylinder head, which could result in loss of control of the aircraft.*

Dates: This AD became effective on February 4, 2010.

Supplementary Information:

*The FAA proposed to amend 14 CFR part 39 by superseding AD 2008-19-05, Amendment 39-15672 (73 FR 53105, September 15, 2008), with a 2 proposed AD. The proposed AD applies to Lycoming Engines (formerly Textron Lycoming) models 320, 360, and 540 series, ‘‘Parallel Valve" reciprocating engines, with certain Engine Components, Inc. (ECi) cylinder assemblies, part number (P/N) AEL65102 series ‘‘Titan," installed. We published the*

*proposed AD in the Federal Register on July 30, 2009 (74 FR 37955). That action proposed to require initial and repetitive visual inspections and compression tests to detect cracks at the head to barrel interface, replacement of cylinder assemblies found cracked, and replacement of certain cylinder assemblies at new, reduced times-in-service, and for an expanded population of cylinder assemblies.*

Service Bulletin B06-01 E (SB)
Source: Manufacturer

*FAA Approved Number: B06-01 E Replaces B06-01 D Superior Ref CR Page 1 of 9 Controlled VIEW*
*Date: 24 January 2007 Mandatory Service Bulletin No: B06-01 Subject:*
*Cylinder assembly recall due to head cracking.*
*Superior Part numbers SA47000L-A1, SA47000L-A20P, SA47000S-A1, SA47000S-A20P, SA47000S-A21P, SA52000- A1, SA52000-A20P, SA52000-A21P, SA52000-A22P, SA52000-A23P, SA55000-A1, SA55000-A20P SL32000W-A1, SL32000W-A20P, SL32000W-A21P, SL32000WH-A1, SL32000WH-A20P, SL32006W-A1, SL32006W-A20P, SL32006W-A21P, SL36000TW-A1, SL36000TW-A20P, SL36000TW-A21P, SL36000TW-A22P, SL36000W-A1, SL36000W-A20P, SL36000W-A21P, SL36006W-A1, SL36006W-A20P, SL36006W-A21P Engine Applications: Lycoming Motors Engines: O-470-G, -K, -L, -M, -P, -R, -S, -U IO-470-C, -D, -E, -F,-G,-H, -L, -M, -N, -P, -R, -S, -U, - V IO-520-A, -B, -BA, -C, -D, -E, -F, -J, -K, -L, -M, -BB, -CB, -MB. TSIO-520-AF, -B, -BB, -C, -CE, -D, -DB, -E, -EB, -G, -H, -J, -JB, -K, -KB, -L, -LB, -M, -N, -NB, -P, -R, -T, UB, -VB, -WB IO-550-A, -B, -C, -D, -E, -F, -L Textron Lycoming Engines: O-320-A, -B, -C, -D, -E, -H IO-320-B, -D, -E LIO-320-B AIO-320-A, -B, -C AEIO-320-D, - E O-360-A, -B, -C, -D, -F, -G, -J IO-360-B, -L, -M LO-360-A AEIO-360-B, -H HO-360-C HIO-360-B O-540-A, -B, -E, -F, -G, -H, -J, IO-540-A, -C, -D, -N, -T, -V, -W AEIO-540-D Superior Air Parts, Inc. Engines: Vantage Engine ® O-360-A XP360 Engine ® (Experimental) O-360-A, B IO-360-A,B Issue: Superior Air Parts, Inc. (Superior) has discovered that cylinder assemblies identified in this Service Bulletin were manufactured from cylinder barrels that were not properly hardened to specification. The soft cylinder barrels may result in fatigue cracking of the cylinder head. The propagation of this crack may lead to head / barrel separation and loss of power in flight. This bulletin requires the removal of Superior cylinder assemblies with the serial numbers listed in this Service Bulletin. These affected serial numbers were manufactured between April and November 2005.*

Engine Power Loss In-flight

*Fuel Selector .....switch to tank containing fuel*

*Electric Fuel Pump .....ON*

*Mixture .....RICH*

*Carburettor Heat .....ON*

*Engine Gauges .....check for indication of cause of power loss. If no fuel pressure is indicated, check tank selector position to be sure it is on a tank containing fuel.*

*When power is restored:*

*Carburettor heater .....OFF*

*Electric fuel pump .....OFF*

*If power is not restored, prepare for power off landing.*

*Trim for 73 KIAS.*

**Findings**

The Pilot

1. The instructor was initially issued a Commercial Pilot Licence (CPL) on 9 October 2020. His last validation was conducted on 20 October 2022 with an expiry date of 31 October 2023. The aircraft was endorsed on the instructor's licence. A Class 1 medical certificate was issued to the pilot on 14 September 2022 with an expiry date of 30 September 2023.

2. The student pilot was initially issued a Private Pilot Licence (PPL) on 9 January 2023 with an expiry date of 31 January 2024. The aircraft type was endorsed on his licence. A Class 4 medical certificate was issued to the student pilot on 20 January 2022 with an expiry date of 31 January 2027.

The Approved Person

3. The approved person (AP) who certified the last mandatory periodic inspection (MPI) was appropriately certificated to carry out maintenance on the aircraft. Therefore, maintenance was not a factor in the serious incident.

The Aircraft

4. The aircraft's Certificate of Registration (C of R) was issued to the current owner on 23 July 2002. The Certificate of Airworthiness (C of A) was initially issued on 18 May 2010. The latest C of A was reissued on 12 May 2023 with an expiry date of 31 May 2024.

5. According to the aircraft 's latest Certificate of Release to Service (CRS) and logbooks, the last 100-hour annual inspection was certified on 4 June 2023 at 11684.3 total airframe hours. The latest CRS had an expiry date of 8 June 2024 or at 11784.3 airframe hours, whichever occurs first. The inspection focussed on the cylinders. The fact that the cylinders were covered by the baffles made it difficult to detect the cracks. At the time of the serious incident, the aircraft had accumulated 11695.3 airframe hours. The aircraft was flown a further 11.5 airframe hours since the last annual inspection.

The engine

6. During the maintenance on 4 June 2023, the compression test (blowby test) on cylinders showed good compression on all four cylinders.

7. The operator had complied with the manufacturer's AD *2008-19-05* during the engine overhaul in 2019. The engine had 10191.0 hours.

8. During the serious incident, the engine had 11695.3 hours. The time between overhaul (TBO) is 2200 airframe hours. The engine had accumulated 1504.3 hours since the last overhaul. The engine malfunctioned due to power loss caused by a cylinder head separation. The crack started on the lower side area between the cylinders; the area is covered by inter cylinder baffles. The crack on the cylinder is similar to other engine cracks that were recalled by the manufacturer in 2007.

9. According to the flight folio, there were no recorded or differed defects prior to the serious incident. The maintenance records indicated that the aircraft was maintained in accordance with (IAW) the regulations and approved procedures, therefore, the investigation concluded that the aircraft was airworthy prior to the serious incident.

10. The AD resulted from reports of 10 cylinder heads that separated since the issue of the AD 2008-19-05.

11. The approved training organisation (ATO) was issued a Declared Training Organisation Certificate (DTOC) on 18 October 2021 with an expiry date of 17 October 2026.

12. The AMO which certified the last maintenance inspection (annual inspection) prior to the serious incident flight had an approved AMO certificate that was issued by the Regulator (SACAA) on 16 January 2023 with an expiry date of 31 February 2024.

13. According to the investigation, the aircraft encountered an in-flight loss of engine power and the rough running engine. Subsequently, the pilot performed a successful forced landing at

FAGT Runway 34. The occupants were not injured and the aircraft was not damaged other than what caused loss of power, which was found post-incident.

**Probable Cause**

The aircraft encountered an in-flight loss of engine power due to a cylinder head fatigue crack. The pilot executed a successful forced landing at FAGT on Runway 34.

**Contributing Factors**

None.

**Safety Action(s)**

None.

**Recommendation**

Following the issuance of the SB B06-01 E and AD 2009-26-12, the operators are still experiencing cracks on cylinder heads. Therefore, it is recommended that the manufacturer conducts further research to prevent future failures/cracks in cylinder heads or reduce the time between overhaul (TBO) from 2200 hours to 1500 hours.

**About this Report**

*The decision to conduct a limited investigation is based on factors including whether the cause is known and the evidence supporting the cause is clear, the level of safety benefit likely to be obtained from an investigation and that will determine the scope of an investigation. For this occurrence, a limited investigation has been conducted, and the Accident and Incident Investigations Division (AIID) has relied on the information submitted by the affected person/s and organisation/s to compile this limited report. The report has been compiled using information supplied in the initial notification, as well as from follow-up desktop inquiries to bring awareness of potential safety issues to the industry in respect of this occurrence, as well as safety action/s that the industry might want to consider in preventing a recurrence of a similar occurrence.*

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

***Purpose***

*In terms of Regulation 12.03.1 of the Civil Aviation Regulations (CAR) 2011 and ICAO Annex 13, 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 apportion blame or liability.*

**Disclaimer**



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