AIRCRAFT SERIOUS INCIDENT REPORT AND EXECUTIVE SUMMARY

			Reference:			CA18/3/2/1344	
Aircraft Registration	**ZS-FIY**	**Date of Incident**	22 May 2021		**Time of Incident**	1145Z	
Type of Aircraft	Cessna 182L		**Type of Operation**		Private (Part 91)		
Pilot-in-command Licence Type	Private Pilot Licence		**Age**	52	**Licence Valid**	Yes	
Pilot-in-command Flying Experience	**Total Flying Hours**		415.5		**Hours on Type**	318.9	
Last Point of Departure	Ermelo Aerodrome (FAEO), Mpumalanga Province						
Next Point of Intended Landing	Ermelo Aerodrome (FAEO), Mpumalanga Province						
Damage to Aircraft	Minor						

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

Private farm, next to Arnot Power Station Airfield (GPS co-ordinates: 25°55'56.5" South 29°49'17.7" East) at an elevation of 5 625ft

Meteorological Information	Surface wind: 360º/5kts, temperature: 17ºC; dew point: 6ºC; cloud cover: CAVOK, visibility: 9999m, QNH: 1030hPa						
Number of People On-board	1 + 1	**Number of People Injured**	0	**Number of People Killed**	0	**Other (On Ground)**	0

Synopsis

On Saturday, 22 May 2021, a pilot accompanied by a passenger on-board a Cessna 182L aircraft with registration ZS-FIY took off from Runway 13 at Ermelo Aerodrome (FAEO) in Mpumalanga province to participate in the 2021 President's Trophy Air Race. The pilot reported that take-off was without incident; however, during the flight, the engine started to run rough and, thereafter, lost power. At that point, the aircraft started to lose height. The pilot elected to execute a forced landing on an open piece of farmland located next to Arnot Power Station Airfield. The aircraft landed safely but had damage to the engine on the number 5 cylinder and the right main wheel fairing. No person was injured during the incident.

Post-incident investigation of the engine established that during flight, the rocker shaft boss failed probably due to fatigue, causing the engine to run rough and vibrate before losing power. The pilot stated that he followed the emergency procedures as stipulated in the Pilot's Operating Handbook (POH) after the engine lost power. The pilot executed a successful forced landing on an open grass field (farm land).

Probable Cause and Contributory Factors

During flight, the engine's number 5 cylinder rocker shaft boss failed probably due to fatigue, causing the engine to run rough and vibrate before losing power.

SRP Date	8 March 2022	Publication Date	14 March 2022

DESCRIPTION OF THE SERIOUS INCIDENT

Reference Number	**:** CA18/3/2/1344
Name of Owner	**:** J.J. Human
Name of the Operator	**:** Private (Part 91)
Manufacturer	**:** Cessna Aircraft Company
Model	**:** 182L
Nationality	**:** South African
Registration Marks	**:** ZS-FIY
Place	**:** Private farm, next to the Arnot Power Station Airfield, Mpumalanga
Date	**:** 22 May 2021
Time	**:** 1145Z

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 incident was notified to the Accident and Incident Investigations Division (AIID) on 22 May 2021. There were no investigator/s dispatched to the site; a desktop investigation was conducted. The investigator/s co-ordinated with all authorities on site by initiating the investigation process according to CAR Part 12 and investigation procedures. 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:

- *Incident — this investigated incident*
- *Aircraft — a Cessna 182L involved in this incident*
- *Investigation — the investigation into the circumstances of this incident*
- *Pilot — the pilot involved in this incident*
- *Report — this incident 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:
This report is produced without prejudice to the rights of the AIID, which are reserved.

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ABBREVIATION	DESCRIPTION
AIID	Accident and Incident Investigations Division
AMO	Aircraft Maintenance Organisation
CAR	Civil Aviation Regulations
CVR	Cockpit Voice Recorder
C of A	Certificate of Airworthiness
C of R	Certificate of Registration
CRS	Certificate of Release to Service
FAEO	Ermelo Aerodrome
FDR	Flight Data Recorder
FT	Feet
GPS	Global Positioning System
kt	Knot
Km	Kilometre
M	Metre
MHz	Megahertz
Mph	Miles Per Hour
MPI	Mandatory Periodic Inspection
NM	Nautical Mile
PIC	Pilot-in-command
QNH	Barometric Pressure Adjusted to Sea level (Query Nautical Height)
RPM	Revolutions per minute
RWY	Runway
SACAA	South African Civil Aviation Authority
SAWS	South African Weather Service
TBO	Time Between Overhaul
UTC	Co-ordinated Universal Time
VFR	Visual Flight Rules
Z	Zulu (Term for Universal Co-ordinated Time - Zero Hours Greenwich)

1. FACTUAL INFORMATION

1.1. History of Flight

1.1.1 On Saturday, 22 May 2021, a pilot accompanied by a passenger on-board a Cessna 182L aircraft with registration ZS-FIY took off from Ermelo Aerodrome (FAEO) in Mpumalanga province with the intention to participate in the 2021 President's Trophy Air Race.

1.1.2 The pilot stated that he took off from Runway 13 at FAEO at 1130Z without incident and reached cruise level at 6300 feet (ft) with 2 450 revolutions per minute (rpm) on the engine gauge and 22 inches of manifold pressure; temperature and pressures were in the green. After 15 minutes of flight, the engine started to run rough and, subsequently, lost power. At this point, the aircraft started to lose height. The pilot elected to execute a forced landing on an open field next to Arnot Power Station Airfield. During the landing sequence, the aircraft sustained damage to the wheel fairing. The pilot and the passenger reported no injuries.

1.1.3 The serious incident occurred during day light on an open field next to Arnold Power Station Airfield at Global Positioning System (GPS) co-ordinates: 25° 55' 56.5" South 29° 49' 17.7" East, at an elevation of 5 625 feet (ft).

Figure 1: An overlay of the location of the aircraft (pin) and Arnot Power Station Airfield (arrow). (Source: Google Earth)

1.2. Injuries to Persons

Injuries	Pilot	Crew	Pass.	Total On-Board	Other
Fatal	-	-	-	-	-
Serious	-	-	-	-	-
Minor	-	-	-	-	-
None	1	-	1	2	-
Total	1	-	1	2	-

Note: Other means people on the ground.

1.3. Damage to Aircraft

1.3.1. The aircraft sustained minor damage to the engine on cylinder number 5 and wheel fairing.

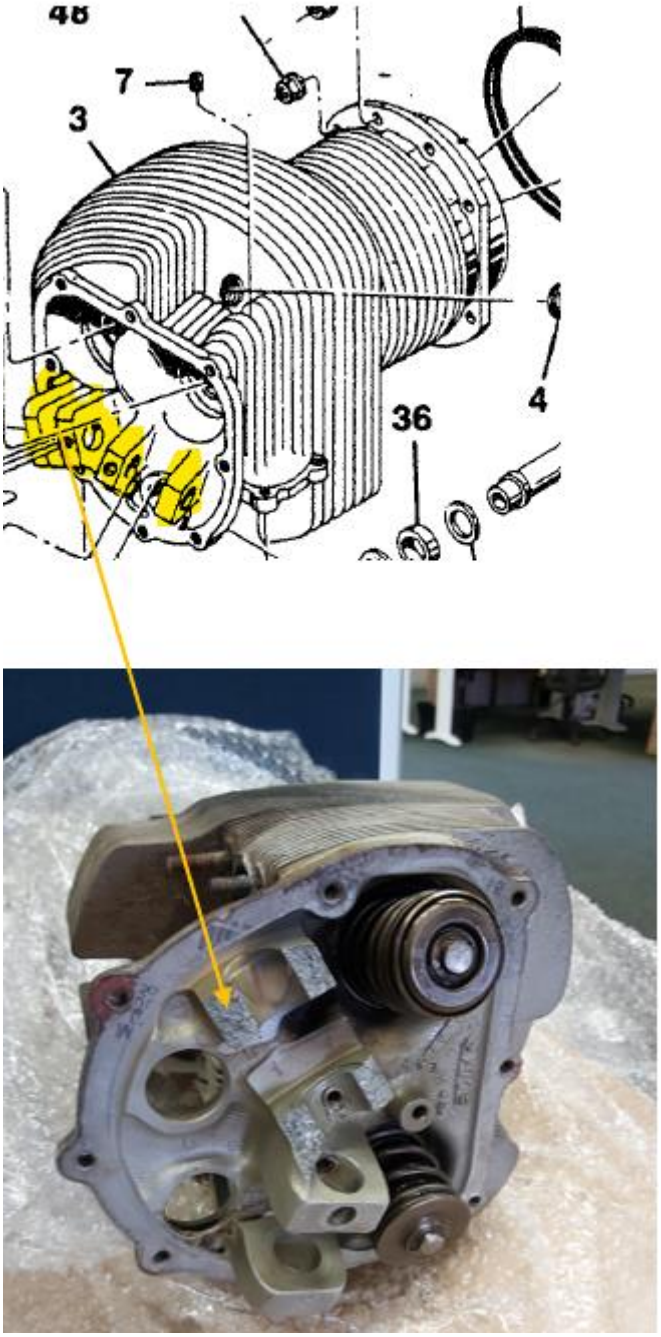

Figure 2: Damage caused to the number 5 cylinder rocker shaft boss.

1.4. Other Damage

1.4.1. None.

1.5. Personnel Information

Pilot (PIC):

Nationality	South African	Gender	Male	Age	52
Licence Number	*********	Licence Type	Private Pilot Licence		
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	None				
Medical Expiry Date	30 November 2021 (Class 2)				

Restrictions	Yes, not to conduct night flights
Previous Incidents	None

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

Flying Experience:

Total Hours	415.5
Total Past 24 Hours	0.8
Total Past 7 Days	3.6
Total Past 90 Days	13.3
Total on Type Past 90 Days	13.3
Total on Type	318.9

1.5.1 The pilot was initially issued a Private Pilot Licence on 27 August 2014. The pilot did his proficiency test on 30 November 2020 and was issued a licence on the same day with an expiry date of 31 August 2022. The pilot was in possession of a Class 2 aviation medical certificate which was issued on 26 November 2020 with an expiry date of 30 November 2021, and with a restriction not to engage in night flights.

Aircraft Maintenance Engineer (AME):

Nationality	South African	Gender	Male	Age	52
Licence Type	Aircraft Maintenance Engineer				
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	Cessna 188 series, Textron Lycoming engines, Continental				
Restrictions	None				
Previous Incidents	None				

1.5.2 The aircraft maintenance engineer (AME) who performed the last mandatory periodic inspection (MPI) on the aircraft prior to the incident flight was in possession of an Aircraft Maintenance Engineer Licence. The AME was initially issued an Aircraft Maintenance Engineer Licence on 16 August 1995 with an expiry date of 26 October 2022. According to the reviewed records, the aircraft type was endorsed on his licence, and he was rated on this aircraft type.

1.6. Aircraft Information

1.6.1 Cessna 182L (Source: Cessna 182 Service Manual)

The Cessna 182 is a high-wing, strut braced monoplane of all metal, semi-monocoque construction. These aircraft are equipped with a fixed tricycle landing gear. The steerable nose gear is equipped with an air hydraulic fluid shock strut. The aircraft has four place seating as a standard. These 182 models are equipped with a six cylinder horizontally

opposed air cooled 0-470 series Continental engine, driving an all metal, constant speed propeller. These aircraft feature rear side windows, a wrap-around rear window and a swept back fin and rudder.

Airframe:

Manufacturer/Model	Cessna 182L	
Serial Number	182-59062	
Aircraft Manufacturer	Cessna Aircraft Company	
Year of Manufacture	1968	
Total Airframe Hours (at time of incident)	4 034.5	
Last MPI (Hours & Date)	3 998.85	19 February 2021
Hours Since Last MPI	35.65	
C of A (Issue date)	21 November 2014	
C of A (Expiry date)	30 November 2021	
C of R (Issue date) (Present Owner)	7 November 2003	
Operating Categories	Part 91	
Type of Fuel Used	Avgas	
Previous Incidents	None	

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

1.6.2 The last maintenance inspection prior to the incident flight was carried out on 19 February 2021 at 3998.85 airframe hours. The inspections carried out on 19 February 2021 were: MPI, 50-hour inspection, 100-hour inspection, 200-hour inspection, blow-by-leak check on six cylinders and a 12-year inspection, which does not include a NDT. The aircraft was issued a Certificate of Release to Service (CRS) on 19 February 2021 with an expiry date of 18 February 2022 or at 4098.95 hours, whichever occurs first.

1.6.3 The Pilot's Operating Handbook (POH) stipulates that at cruise level, the aircraft power must be between 15 and 23 inches manifold pressure and the revolutions per minute (rpm) must be between 2200 and 2450rpm.

CRUISE.

(1) Power -- 15-23 INCHES Hg., 2200-2450 RPM (no more than 75%).
(2) Mixture -- LEAN.
(3) Cowl Flaps -- CLOSED.

Figure 3: Extract from the Cessna 182L Pilot's Operating Handbook.

Engine:

Manufacturer/Model	Continental O-470-R
Serial Number	203101-9-R
Hours Since New	4 016.98
Hours Since Overhaul	1 280.14

1.6.4 According to the aircraft maintenance organisation (AMO), the aircraft's engine was overhauled at 1500 engine hours on 10 January 2003. On 14 August 2012, the aircraft was fitted with a serviceable cylinder. On 4 September 2012, the aircraft's engine with serial number 203101-9-R had cylinder 1 and 5 removed due to low compression. The AME stated that non-destructive testing (NDT) was carried out on the engine parts, which included rocker arms, during overhaul. The AMO could not locate any logbooks and results of that NDT except for a document from Master Tech Aviation stating that an NDT had been carried out (see Appendix 1). The logbooks that were reviewed had no entries regarding the NDT and engine overhaul. The same engine was then flown for 1280.14 hours since its last overhaul and had 220.53 hours left until its next overhaul, according to the AMO status report. Service Bulletin 96-12 stipulated visual inspections, annual inspections, compression checks and leak checks procedures for maintenance of engines, which were carried out by the AMO.

1.6.5 Post-incident, the remaining 5 cylinders were removed and sent to the Aircraft Powerplant Company (Pty) Ltd in Pretoria for NDT (Florescent Dye Inspection and Magnetic Particle inspection) and repairs. The number 5 replacement cylinder was already inspected and repaired. All parts passed the inspections and tests that were performed on them as per the TCM SB 96-12 Part 2 and TCM Standard Practice Maintenance Manual.

Propeller:

Manufacturer/Model	Hartzell
Serial Number	NT123B
Hours Since New	450
Hours Since Overhaul	TBO not reached

1.6.6 The boss that is highlighted in Diagram 1 is part of the cylinder. Precaution is taken when cleaning these assemblies (parts). These machined surfaces must be protected during blasting operation.

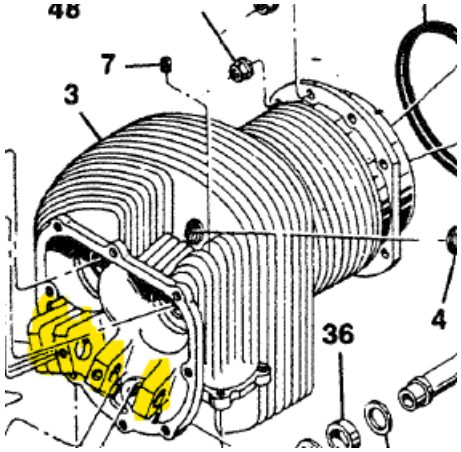

Diagram 1: Cylinder showing cylinder boss (highlight). (Source: Cessna 182 Service Manual)

1.7. Meteorological Information

1.7.1 The weather information in the table below was provided by the South African Weather Service (SAWS) for Ermelo (Mpumalanga) on 22 May 2021 at 1010Z.

Wind Direction	360º	Wind Speed	5kts	Visibility	9999m
Temperature	17ºC	Cloud Cover	CAVOK	Cloud Base	CAVOK
Dew Point	6ºC	QNH	1030hPa		

1.8. Aids to Navigation

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

1.9. Communication

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

1.10. Aerodrome Information

The pilot forced landed the aircraft on an open piece of farm land, 2nm north-east of Arnot Power Station Airfield.

Aerodrome Location	Arnot Power Station Airfield, Mpumalanga
Aerodrome Status:	Unregistered
Aerodrome Co-ordinates	25°56’28.57” S 29°48’36.97” E
Aerodrome Altitude	5594 ft
Runway Headings	13/31

Runway Dimensions	1158m x 10m
Runway Used	none
Runway Surface	Asphalt
Approach Facilities	None
Radio Frequency	Unknown

1.11. Flight Recorders

1.11.1 The aircraft was not equipped with a flight data recorder (FDR) or a cockpit voice recorder (CVR), nor was it required by regulation to be fitted to this aircraft type.

1.12 Wreckage and Impact Information

1.12.1 None.

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 incident was considered survivable as there was no damage to the cabin or cockpit area that would have caused injury to the occupants.

1.16 Tests and Research

1.16.1 With this type of failure experienced on aircraft around the world, an Airworthiness Bulletin (AWB) was issued by the Australian Government Civil Aviation Safety Authority requesting aircraft operators to follow the instructions listed in the AWB (see Appendix B).

1.16.2 The method of using magnetic particle inspection is a form of non-destructive testing (NDT) which critical aircraft components are subjected to during overhaul (source: Continental Maintenance Manual).

72-30-03 MAGNETIC PARTICLE INSPECTION. Inspection by the Magneflux method must be conducted on all ferrous parts listed in Section 72-30-03, and in accordance with the methods and data in the table before dimensional inspection. The Magnaglow method is recommended whenever the necessary equipment is available. This method employs magnetic particles coated with a flourescent organic material which may be illuminated with a "black light", as in the Zyglo process, to amplify an indication of weakness. If a crankshaft is doubtful after a circular magnetization and inspection, demagnetize and remagnetize it longitudinally for further inspection.

NOTE . . . Before magnetic particle inspection, piston pins and valve rocker shafts must be polished with crocus cloth. TCM recommends 100% replacement of piston pins regardless of condition.

CAUTION . . . Before magnetic particle inspection of any part, plug small holes leading to obscure cavities with tight-fitting wood plugs or with a hard grease which is soluble in lubricating oil to prevent particles from lodging in places where they would be difficult to remove and places that are not subject to visual inspection. After magnetic particle inspection, remove all such plugs and clean the part thoroughly in solvent, and dry with compressed air. Check for complete demagnetization.

Figure 7: Inspection extract from the Continental Maintenance Manual.

FLOURESCENT METHOD PREFERRED,
WET CONTINUOUS PROCEDURE REQUIRED

Part	*Method of Magnetization	AC or DC Amperes	Critical Areas	Possible Defects
Crankshaft	Circular and Longitudinal	2000	Journals, fillets, oil holes, thrust flanges, prop flange.	Fatigue cracks, heat cracks, flange cracks, from prop strike.
Connecting Rod	Circular and Longitudinal	1500	All areas.	Fatigue cracks.
Camshaft	Circular and Longitudinal	1500	Lobes, Journals drilled hole edges.	Heat cracks. Fatigue cracks.
Piston Pin	Circular and Longitudinal	1000	Shear planes, ends, center.	Fatigue cracks.
Rocker Arms	On Conductor Bar and single Between Heads	1000 800	Pad, socket under side arms and boss.	Fatigue cracks.
Gears to 6 Inch Diameter	Circular or on Center Conductor	1000 to 1500	Teeth, Splines, Keyways.	Fatigue cracks.
Gears over 6 Inch Diameter	Shaft Circular Teeth Between Heat Two Times 90°	1000 to 1500	Teeth, Splines.	Fatigue cracks.
Shafts	Circular and Longitudinal	1000 to 1500	Splines, Keyways, Change of Section.	Fatigue cracks, heat cracks.
Thru Bolts Rod Bolts	Circular and Longitudinal	500	Threads Under Head.	Fatigue cracks.
Cylinder Barrels	Circular and Longitudinal	1500	All areas.	Fatigue cracks. Heat cracks.

Figure 8: Extract from the Continental Maintenance Manual showing specific engine parts to be tested.

1.16.3 Propulsion system reliability (Source: Aviation Research and Analysis Report – B20070191)

It is important to recognise that, in reciprocating-engine installations, the engine and propeller form an interdependent system. Constant-speed propellers are used in conjunction with high-power reciprocating engines. This combination allows the propeller speed and engine power to be set separately, to obtain the best combination of performance and fuel economy, for all phases of flight. Just as the engine and propeller form an interdependent system, the engine subsystems and fuel consumed in the engine form an interdependent system. Engine performance and fuel properties are closely linked.

Reliability is not a fundamental property of an engine. It is a result of the correct performance of all subsystems through the phases of design, manufacture, operation and maintenance. The confidence that an aircraft engine will perform reliably and that the risks are managed is established by a certification process. The engine design, along with approved instructions for operating limits, lubrication, inspection, component replacement, and testing and adjustment, must pass an extensive testing program. Reliability may be expressed in qualitative terms or quantitative terms. A correlation between the qualitative and quantitative terms, along with descriptors of failure severity and effect on aircraft and aircraft occupants. It is normally accepted that a reliable system has a probability of failure of 1 in 10,000,000 or that the probability of failure is extremely remote (improbable).

1.17 Organisational and Management Information

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

1.17.2 The AMO which carried out the last maintenance inspection prior to the incident flight was in possession of an AMO certificate which was issued by the SACAA on 8 February 2021 with an expiry date of 28 February 2022. According to the Operations Specifications, the AMO had the required ratings and had been authorised to carry out maintenance on the aircraft type. The aircraft was maintained in accordance with Part 145 of the Civil Aviation Regulations (CAR) 2011 as amended.

1.18 Additional Information

1.18.1 **CAR 2011 Part 43.04.3 Validity of a certificate of release to service**

(1) A certificate of release to service for an aircraft shall be valid for—

(*a*) a period not exceeding 12 months or 100 hours of flight time, whichever comes first; or

(*b*) such other time as approved in the inspection programme referred to in sub-regulation 43.02.8 (2) (*a*) (ii).

(2) When a certificate of release to service becomes invalid due to an aircraft sustaining a defect not affecting the primary structure, the validity of the certificate is restored when the defect has been rectified and the necessary certification has been made.

(3) When a certificate of release to service becomes invalid due to an aircraft sustaining a serious defect in an accident or incident that affects the serviceability of a Class I product, the certificate of airworthiness shall be invalidated.

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 incident. This shall not be read as apportioning blame or liability to any particular organisation or individual.

2.2. Analysis

2.2.1 The pilot was initially issued a Private Pilot Licence on 27 August 2014. The pilot did his proficiency check on 30 November 2020 with an expiry date of 31 August 2022. The pilot was in possession of a Class 2 aviation medical certificate which was issued on 26 November 2020 with an expiry date of 30 November 2021, and with a restriction not to engage in night flights.

2.2.2 The AME who performed the last mandatory maintenance inspection (MPI) on the aircraft prior to the incident flight was in possession of a valid Aircraft Maintenance Engineer Licence. The AME was initially issued an Aircraft Maintenance Engineer Licence on 16 August 1995 with an expiry date of 26 October 2022. According to the reviewed records, the aircraft type was endorsed on his licence, and he was rated on this aircraft type.

2.2.3 On 14 August 2012, the aircraft's engine with serial number 203101-9-R had cylinder 1 and 5 replaced with serviceable cylinders due to low compression (note: serviceable cylinders are not new cylinders).

2.2.4 The aircraft's engine was overhauled at 1500 engine hours on 10 January 2003. The AMO could not locate the results of the NDT that was carried out, and there were no entries in the logbook for the overhaul except for a document from Master Tech Aviation stating that a

NDT was carried out. The same engine was then flown for 1280.14 hours since its last overhaul and had 220.53 hours left until its next inspection, according to the AMO status report.

2.2.5 The last MPI was conducted on 19 February 2021 at 3998.85 airframe hours and the aircraft had flown a total of 35.65 hours since its last MPI, according to the owner/operator questionnaires. On 19 February 2021, the inspections carried out were: MPI, 50-hour inspection, 100-hour inspection, 200-hour inspection, blow-by-leak check on six cylinders and a 12-year inspection, which does not include a NDT. The aircraft was issued a Certificate of Release to Service (CRS) on 19 February 2021 with an expiry date of 18 February 2022 or at 4098.95 hours, whichever occurs first.

2.2.6 Post-incident, the remaining 5 cylinders were removed and sent to the Aircraft Powerplant Company (Pty) Ltd in Pretoria for a NDT (Florescent Dye Inspection and Magnetic Particle inspection) and repairs. The replacement cylinder had already been inspected and repaired. All parts passed the inspections and tests that were performed on them as per the TCM SB 96-12 Part 2 and TCM Standard Practice Maintenance Manual.

2.2.7 The pilot flew the aircraft at the correct rpm values (2450 rpm) during the cruise phase at the time of the incident as prescribed in the Pilot's Operating Handbook (see Figure 8). The pilot reported that the engine ran rough, followed by power loss; he then elected to execute an emergency landing on an open field (farmland) next to Arnot Power Station Airfield.

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2.2.8 Post-incident investigation established that it is likely that during the flight, the rocker shaft boss lugs failed due to fatigue, causing the engine to run rough as a result of vibration and, subsequently, lost power. The pilot followed the emergency procedures as stipulated in the POH after the engine lost power. The aircraft started losing height and the pilot executed a successful forced landing on an open grass field (farm land).

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 on 27 August 2014. The pilot did his proficiency on 30 November 2020 with an expiry date of 31 August 2022. The pilot was in possession of a Class 2 aviation medical certificate which was issued on 26 November 2020 with an expiry date of 30 November 2021, and with a restriction not to engage in night flights.

3.2.2 The AME who performed the last MPI on the aircraft prior to the incident flight was in possession of an Aircraft Maintenance Engineer Licence. The AME was initially issued an Aircraft Maintenance Engineer Licence on 16 August 1995 with an expiry date of 26 October 2022. According to the reviewed records, the aircraft type was endorsed on his licence.

3.2.3 The aircraft was issued a Certificate of Airworthiness on 21 November 2014 with an expiry date of 30 November 2021. The aircraft was issued a Certificate of Registration (C of R) on 7 November 2003.

3.2.4 On 14 August 2012, the aircraft's engine with serial number 203101-9-R had cylinder 1 and 5 replaced with serviceable cylinders due to low compression (note: serviceable cylinders are not new cylinders).

3.2.5 The aircraft's engine was overhauled at 1500 engine hours on 10 January 2003. The AMO could not locate the results of the NDT that was carried out except for a document from Master Tech Aviation stating that a NDT was carried out. The same engine was then flown for 1280.14 hours since its last overhaul and had 220.53 hours left until its next inspection, according to the AMO status report.

3.2.6 The last MPI was conducted on 19 February 2021 at 3998.85 airframe hours and the aircraft had flown a total of 35.65 hours since its last MPI, according to the owner/operator questionnaires. On 19 February 2021, the inspections carried out were: MPI, 50-hour

inspection, 100-hour inspection, 200-hour inspection, blow-by-leak check on six cylinders and a 12-year inspection, which does not include an NDT. The aircraft was issued a Certificate of Release to Service (CRS) on 19 February 2021 with an expiry date of 18 February 2022 or at 4098.95 hours, whichever occurs first.

3.2.7 Post-incident, the remaining 5 cylinders were removed and sent to the Aircraft Powerplant Company (Pty) Ltd in Pretoria for a NDT (Florescent Dye Inspection and Magnetic Particle inspection) and repairs. The replacement cylinder was already inspected and repaired. All parts passed the inspections and tests that were performed on them as per the TCM SB 96-12 Part 2 and TCM Standard Practice Maintenance Manual.

3.2.9 The pilot reported that the engine ran rough, followed by power loss; he then executed an emergency landing on an open field (farmland) next to Arnot Power Station Airfield.

3.2.10 The logbook copies that were reviewed had no entries regarding the NDT and engine overhaul carried out on 10 January 2003.

3.2.11 The engine investigation established that it is likely that during flight, the rocker shaft boss failed due to fatigue, causing the engine to run rough as a result of vibration and, subsequently, lost power. The pilot followed the emergency procedures as stipulated in the POH after the engine lost power. The aircraft started losing height and the pilot executed a successful forced landing on an open grass field (farm land).

3.3. Probable Cause

3.3.1 It is likely that during flight, the rocker shaft boss failed due to fatigue, causing the engine to run rough as a result of vibration and, subsequently, lost power.

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 message

4.2.1 None.

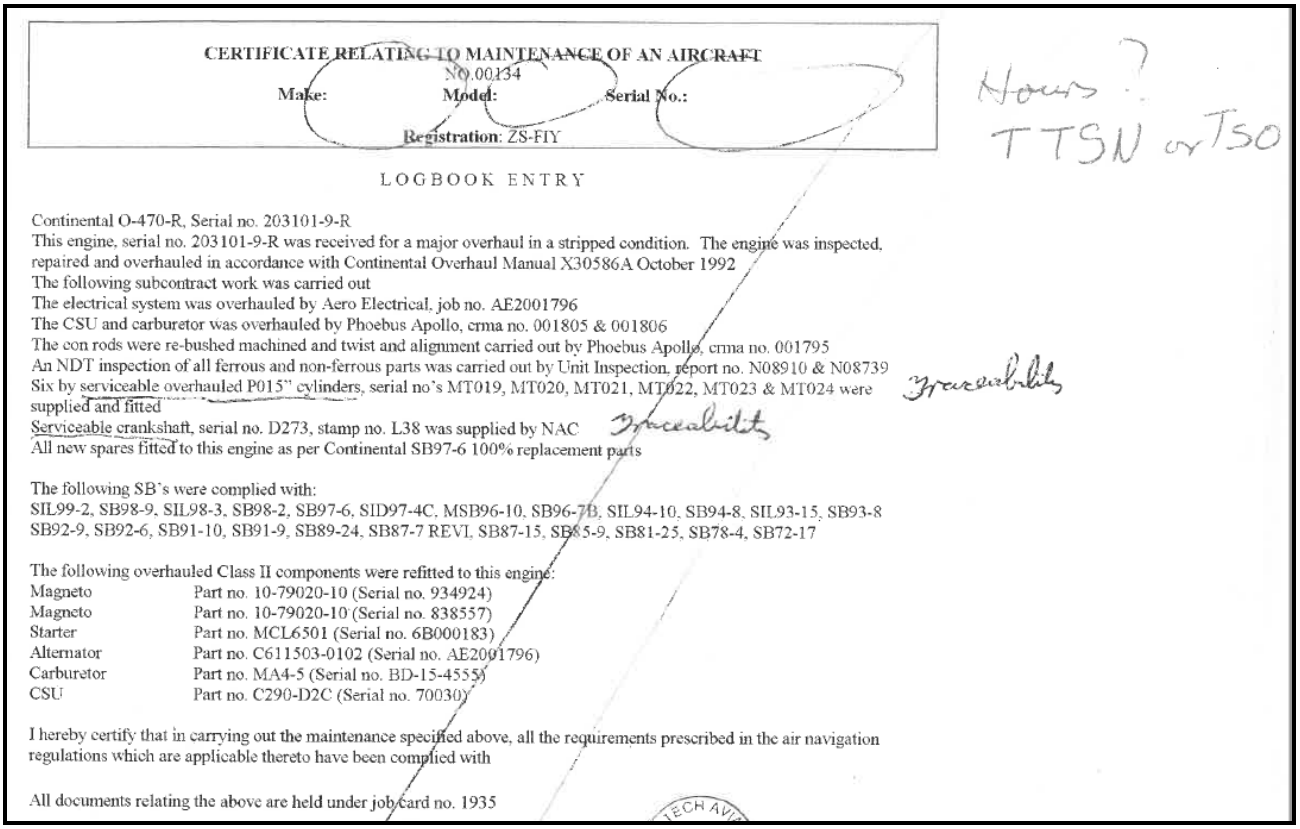
5. APPENDICES

5.1 Appendix A – Certificate relating to Maintenance of Aircraft

5.2 Appendix B – Airworthiness Bulletin

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

Appendix A



CERTIFICATE RELATING TO MAINTENANCE OF AN AIRCRAFT
NO.00134
Make: **Model:** **Serial No.:**
Registration: ZS-FIY

Hours ? TTSN or TSO

LOGBOOK ENTRY

Continental O-470-R, Serial no. 203101-9-R
This engine, serial no. 203101-9-R was received for a major overhaul in a stripped condition. The engine was inspected, repaired and overhauled in accordance with Continental Overhaul Manual X30586A October 1992
The following subcontract work was carried out
The electrical system was overhauled by Aero Electrical, job no. AE2001796
The CSU and carburetor was overhauled by Phoebus Apollo, crma no. 001805 & 001806
The con rods were re-bushed machined and twist and alignment carried out by Phoebus Apollo, crma no. 001795
An NDT inspection of all ferrous and non-ferrous parts was carried out by Unit Inspection, report no. N08910 & N08739
Six by serviceable overhauled P015" cylinders, serial no's MT019, MT020, MT021, MT022, MT023 & MT024 were supplied and fitted
Serviceable crankshaft, serial no. D273, stamp no. L38 was supplied by NAC
All new spares fitted to this engine as per Continental SB97-6 100% replacement parts

Traceability
Traceability

The following SB's were complied with:
SIL99-2, SB98-9, SIL98-3, SB98-2, SB97-6, SID97-4C, MSB96-10, SB96-7B, SIL94-10, SB94-8, SIL93-15, SB93-8 SB92-9, SB92-6, SB91-10, SB91-9, SB89-24, SB87-7 REVI, SB87-15, SB85-9, SB81-25, SB78-4, SB72-17

The following overhauled Class II components were refitted to this engine:

Magneto	Part no. 10-79020-10 (Serial no. 934924)
Magneto	Part no. 10-79020-10 (Serial no. 838557)
Starter	Part no. MCL6501 (Serial no. 6B000183)
Alternator	Part no. C611503-0102 (Serial no. AE2001796)
Carburetor	Part no. MA4-5 (Serial no. BD-15-4555)
CSU	Part no. C290-D2C (Serial no. 70030)

I hereby certify that in carrying out the maintenance specified above, all the requirements prescribed in the air navigation regulations which are applicable thereto have been complied with

All documents relating the above are held under job card no. 1935

Appendix B

Australian Government
Civil Aviation Safety Authority

AIRWORTHINESS BULLETIN

Piston Engine Rocker Shaft Boss Failures

AWB 85-016 Issue : 1
Date : 2 August 2013

1. Applicability

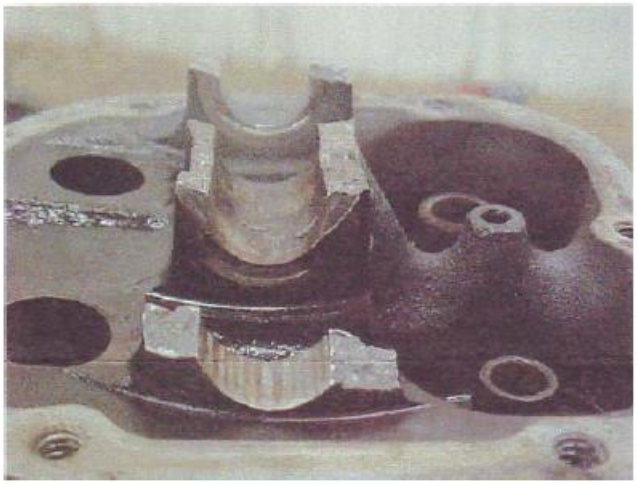
All reciprocating engines.

2. Purpose

Alert operators and maintainers to the hazard of loss of power and in-flight engine failures resulting from rocker shaft boss failures.

3. Background

Service Difficulty Reports continue to be received describing in flight failures of cylinder rocker shaft bosses. The outer boss or lug typically breaks off at the base first, overstressing the centre boss leading to the rocker shaft breaking through the top of the centre lug or boss as the engine continued to operate. This type of failure results in a rough running engine which will not develop full RPM and power and, in some cases, may result in total engine failure.



Many failures may be attributed to not following the engine manufacturer's overhaul and maintenance instructions and / or not following good overhauling component handling practices. The bosses are cast into the head and are susceptible to any shock loading.

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