AIRCRAFT SERIOUS INCIDENT REPORT AND EXECUTIVE SUMMARY

		Reference:		**CA18/3/2/1356**	
Aircraft Registration	**ZS-SPB**	**Date of Incident**	1 August 2021	**Time of Incident**	0956Z
Type of Aircraft	Cessna 172N		**Type of Operation**	Training Flight (Part 141)	
Pilot-in-command Licence Type	Commercial Pilot Licence		**Age** 26	**Licence Valid**	Yes
Pilot-in-command Flying Experience	**Total Flying Hours**		285	**Hours on Type**	265.6

Last Point of Departure	Lanseria International Airport (FALA), Gauteng Province
Next Point of Intended Landing	Lanseria International Airport (FALA), Gauteng Province
Damage to Aircraft	None

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

On taxiway Charlie at Global Positioning System (GPS) co-ordinates determined to be S 25˚56´50.62˝ E27˚55´43.68˝ at an elevation of 4458 feet

Meteorological Information	Wind direction: 340°; Wind speed: 6kts; Visibility: +10km; Temperature: 17°C; Cloud cover: CAVOK; Cloud base: Nil; Dew Point: -2°C						
Number of People On-board	2+0	**Number of People Injured**	0	**Number of People Killed**	0	**Other (On Ground)**	0

Synopsis

On Sunday morning, 1 August 2021 at approximately 0932Z, an instructor and a student pilot on-board a Cessna 172N aircraft with registration ZS-SPB took off from Runway 07 at Lanseria International Airport (FALA) in Gauteng province to engage in circuit flight training and, thereafter, land at the same airport.

The student pilot stated that while they were on downwind for Runway 07, the aircraft's engine ran rough and subsequently stopped. He attempted to restart it but was unsuccessful. He then decided to execute an emergency landing on taxiway Charlie; and the aircraft landed safely at approximately 0956Z. The aircraft was not damaged, and both occupants were not injured during the incident sequence.

The engine was removed from the aircraft post-incident and was sent to an approved engine workshop for inspection, which revealed the crankshaft that had broken into two halves at the Number 4 piston connecting rod journal area due to fatigue cracks.

Probable Cause and Contributory Factor

Probable Cause

In-flight engine stoppage as a result of a failed crankshaft that broke into two halves at the Number 4 piston connecting rod journal area due to fatigue. This was followed by a successful forced landing.

Contributory Factor

Polishing of the connecting rod journal possibly introduced a notch (material weakness) during the engine's last overhaul.

SRP Date	8 November 2022	Publication Date	10 November 2022

Occurrence Details

Reference Number	**:** CA18/3/2/1356
Occurrence Category	**:** Category 2
Type of Operation	**:** Training (Part 141)
Name of Operator	**:** Skyhawk
Aircraft Registration	**:** ZS-SPB
Aircraft Make and Model	**:** Cessna 172N
Nationality	**:** South African
Place	**:** Taxiway Charlie at FALA
Date and Time	**:** 1 August 2021, 0956Z
Injuries	**:** None
Damage	**:** None

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 1 August 2021 at 0956Z. The occurrence was categorised as a serious incident according to the CAR 2011 Part 12 and ICAO STD Annex 13 definitions. The notifications were sent to the State of Registry, Operator, Design and Manufacture in accordance with the CAR 2011 Part 12 and ICAO Annex 13 Chapter 4. Neither of the States appointed an accredited representative and/or advisor. The investigator did not dispatch to the site for this serious incident.

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

- *Incident — this investigated incident*
- *Aircraft — the Cessna 172N 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:

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ABBREVIATION	DESCRIPTION
°	Degrees
'	Minutes of co-ordinates
"	Seconds co-ordinates
AIID	Accident and Incident Investigations Division
AMO	Aircraft Maintenance Organisation
ATO	Aviation Training Organisation
C	Celsius
CAR	Civil Aviation Regulations
CAVOK	Ceiling and Visibility OK
CoA	Certificate of Airworthiness
CoR	Certificate of Registration
CPL	Commercial Pilot Licence
CVR	Cockpit Voice Recorder
DME	Distance Measuring Equipment
E	East
FALA	Lanseria International Airport
FDR	Flight Data Recorder
Ft	Feet
GPS	Global Positioning System
hPa	Hectopascal
ILS	Instrument Landing System
Kts	Knots
MPI	Mandatory Periodic Inspection
PIC	Pilot-in-command
PPL	Private Pilot Licence
QNH	Query Nautical Height
S	South
SACAA	South African Civil Aviation Authority
UTC	Co-ordinated Universal Time
VOR	Very High Frequency Omni-directional Range
Z	Zulu

1. FACTUAL INFORMATION

1.1. History of Flight

1.1.1 On Sunday morning, 1 August 2021 at approximately 0932Z, an instructor and a student pilot on-board a Cessna 172N aircraft with registration ZS-SPB took off on a circuit training flight from Runway 07 at Lanseria International Airport (FALA) in Gauteng province. Visual meteorological conditions (VMC) by day prevailed at the time of the flight. The flight was conducted under visual flight rules (VFR) by day and under the provisions of Part 141 of the Civil Aviation Regulations (CAR) 2011 as amended.

1.1.2 The student pilot, who was the pilot-in-command (PIC), stated that he took off at 0932Z from Runway 07 and completed a single circuit, followed by a touch-and-go landing. During the second circuit whilst at mid-downwind right for Runway 07, the air traffic control (ATC) instructed the crew of the ZS-SPB aircraft to orbit to the left and re-establish on downwind right of Runway 07 to allow the ZS-OHK aircraft, which was orbiting on late downwind right for Runway 07, to land. When the ZS-SPB was orbiting, the engine started to run rough whilst vibrating severely. Thereafter, the pair noticed a rapid loss of power, and a few seconds later, the student pilot heard a “knock” sound before the engine stopped.

1.1.3 The crew immediately initiated the engine failure procedure whilst they assessed the situation, which included re-starting the engine; but without success. The crew transmitted a Mayday call on FALA tower frequency 124.0-Megahertz (MHz). After surveying their surrounds, they identified taxiway Charlie, which is 980 metres long and 20 metres wide, on which to execute an emergency landing. The aircraft landed safely.

1.1.4 Both occupants were not injured. The aircraft was not damaged during the incident sequence. The ZS-OHK aircraft, which had been orbiting on downwind left, landed safely on Runway 07.

1.1.5 The serious incident occurred during daylight, mid-downwind right of Runway 07. The aircraft was forced landed on taxiway Charlie at Global Positioning System (GPS) co-ordinates determined to be S 25˚56´50.62˝ E 27˚55´43.68˝ at an elevation of 4 458 feet (ft).

Figure 1: Serious incident location. (Source: Google Earth)

1.2. Injuries to Persons

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

Note: Other means people on the ground.

1.3. Damage to Aircraft

1.3.1 The aircraft's airframe was not damaged during the serious incident.

1.4. Other Damage

1.4.1 None.

1.5. Personnel Information

1.5.1 Instructor:

Nationality	Indian	Gender	Male	Age	26
Licence Type	Commercial Pilot Licence (CPL)				
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	Night rating, Instruments rating and Instructor Grade 3				
Medical Expiry Date	14 December 2025				
Restrictions	None				
Previous Incidents	None				

1.5.1.1 The instructor was initially issued a Student Pilot Licence (SPL) on 14 November 2019 with an expiry date of 13 November 2020. The instructor was later issued a Private Pilot Licence (PPL) on 18 March 2020 with an expiry date of 31 March 2021. At the time of the serious incident, the instructor had a Commercial Pilot Licence (CPL) issued on 10 February 2021 with an expiry date of 28 February 2022.

1.5.1.2 The instructor was issued a Class 1 aviation medical certificate on 14 December 2020 with an expiry date of 14 December 2025.

Flying Experience:

Total Hours	285
Total Past 24 Hours	3.9
Total Past 7 Days	13.6
Total Past 90 Days	66.2
Total on Type Past 90 Days	66.2
Total on Type	265.6

1.5.2 Student Pilot:

Nationality	Indian	Gender	Male	Age	24
Licence Type	Student Pilot Licence (SPL)				
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	None				
Medical Expiry Date	30 June 2022				
Restrictions	None				
Previous Incidents	None				

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

1.5.2.1 The student pilot was initially issued a Student Pilot Licence (SPL) on 31 July 2021 with an expiry date of 30 July 2022.

1.5.2.2 The student pilot was issued a Class 1 aviation medical certificate on 26 June 2021 with an expiry date of 30 June 2022.

Flying Experience:

Total Hours	21.9
Total Past 24 Hours	2.0
Total Past 7 Days	6.2
Total Past 90 Days	21.9
Total on Type Past 90 Days	21.9
Total on Type	21.9

1.6. Aircraft Information

1.6.1. The Cessna 172 Skyhawk is an American four-seat, single-engine, high-wing, fixed-wing aircraft manufactured by the Cessna Aircraft Company. The Cessna 172 Skyhawk was first flown in 1955. It was developed from the 1948 Cessna 170, but with a tricycle landing gear rather than a conventional landing gear.

Airframe:

Manufacturer/Model	Cessna Aircraft Company/C172N	
Serial Number	172-69348	
Year of Manufacture	1978	
Total Airframe Hours (At Time of Serious Incident)	13 711.8	
Last Inspection (Date & Hours)	2 July 2021	13 624.8
Airframe Hours Since Last Inspection	87	
CRS Issue Date	2 July 2021	
C of A (Issue Date & Expiry Date)	24 August 2010	31 August 2022
C of R (Issue Date) (Present Owner)	15 September 2016	
Operating Category	Standard Normal Category	
Type of Fuel Used	Avgas 100LL	
Previous Serious Incidents	None	

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

1.6.1.1 On 17 March 2020, the aircraft was involved in an accident and sustained damages to the nose section's lower fire wall and the right-wing tip. The propeller was not damaged in the accident sequence; however, the occurrence was not reported to the investigation authority. The fire wall and the wing tip were repaired after the accident, and the aircraft was issued a Certificate of Release to Service (CRS) on 12 May 2020 at 12 731.5 hours, with an expiry date of 12 May 2021 or at 12 781.5 hours, whichever occurs first. The aircraft was also issued a special flight permit on 1 June 2020 for a single flight from FALA to FALA and within a 50 nautical mile (nm) radius. After the special flight, the aircraft was issued a Certificate of Airworthiness (CoA) with an expiry date of 31 August 2021. The aircraft's mandatory periodic inspection (MPI) was carried out on 25 May 2021, and the CRS was issued with an expiry date of 25 May 2022 or at 13 625.4 airframe hours, whichever occurs

first unless the aircraft is involved in an accident or becomes unserviceable, in which case the certificate is invalid for the duration of the period.

Engine:

Manufacturer/Model	Textron Lycoming
Serial Number	L-7233-76
Part Number	0-320-H2AD
Hours Since New	5664.8
Hours Since Overhaul	1 047.1

1.6.1.2 The engine was last overhauled on 12 December 2019. According to the aircraft maintenance organisation (AMO) records (engine logbook), the crankshaft was measured to be M0.003 inches undersize on the main journals and the conrod journals. The corresponding bearings M03-inch for the oversize journals were ordered on 25 November 2019 and were fitted to the crankshaft journals. The AMO stated that they did not resize or grind the journals during this overhaul. They had only polished the journals to accommodate engine assembly. The engine operated for 1 047.1 hours since the last overhaul.

1.6.1.3 According to the maintenance records, Airworthiness Directive (AD) number 98-02-08 was complied with and signed out on 3 August 2015. The AD stated: *action proposed to require initial and repetitive inspections of the crankshaft inside diameter (ID) for corrosion and cracks, and replacement of cracked crankshafts with a serviceable part.* In addition, the proposed AD would have permitted operation of engines with crankshafts that were found to have corrosion pits but were free of cracks, provided repetitive inspections were performed until the next engine overhaul or five (5) years after the initial inspection, whichever occurs first, at which time the proposed AD would have required those crankshafts (with corrosion pits but no cracks) to be replaced. The proposed actions would be performed in accordance with Textron Lycoming Mandatory Service Bulletin (MSB) No. 505A, dated October 18, 1994.

During the last engine overhaul, Service Instruction (SI) 1047 (crankshaft inspection) was complied with, and the engine was found to be in a satisfactory condition.

Propeller:

Manufacturer/Model	McCauley Propeller
Serial Number	OA004
Part Number	2A34C209
Hours Since New	Unknown
Hours Since Overhaul	1 889.6

1.7. Meteorological Information

1.7.1. The weather information below was obtained from the pilot questionnaire.

Wind Direction	340°	Wind Speed	6kts	Visibility	+10km
Temperature	17°C	Cloud Cover	CAVOK	Cloud Base	Nil
Dew Point	-2°C	QNH	1013hPa		

1.8. Aids to Navigation

1.8.1. The aircraft was equipped with standard navigational equipment as approved by the Regulator (SACAA). There were no records indicating that the navigation system was unserviceable prior to the serious incident.

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 serious incident.

1.10. Aerodrome Information

Aerodrome Location	Lanseria, Gauteng Province
Aerodrome Status	Licensed
Aerodrome Co-ordinates	S25°56.90' / E27°54.93' S25°55.83' / E27°56.22'
Aerodrome Altitude	4 521 feet Above Mean Sea Level
Runway Headings	07/25
Runway Dimensions	2996 x 45 metres
Runway Used	07
Runway Surface	Asphalt
Approach Facilities	ILS/DME and VOR
Radio Frequency	124.00

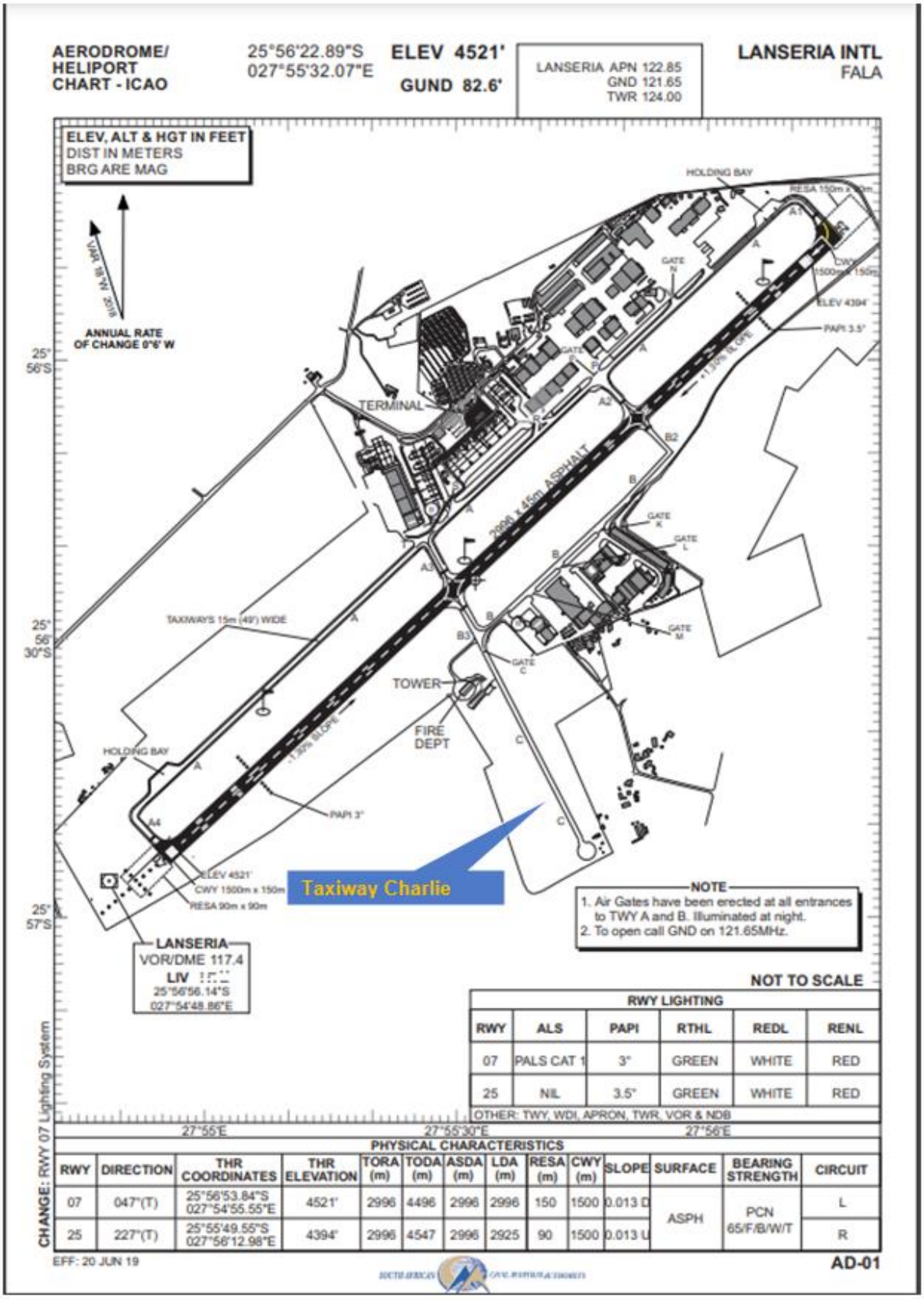


Diagram 1: FALA Airport chart.

1.11. Flight Recorders

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

1.12 Wreckage and Impact Information

1.12.1 The pilot executed a successful emergency landing on taxiway Charlie. The aircraft remained centred on the taxiway and did not sustain any airframe damages.

1.13 Medical and Pathological Information

1.13.1 Not applicable.

1.14 Fire

1.14.1. There was no evidence of a pre- or post-impact fire.

1.15 Survival Aspects

1.15.1 Not applicable.

1.16 Tests and Research

1.16.1 Engine teardown inspection report

1.16.1.1 Following the serious incident, the engine was taken in for a teardown inspection at an AMO facility at Wonderboom Airport in Gauteng province. The AMO was approved in accordance with the SACAA regulations. Post-incident examination of the engine, the Textron Lycoming O-320 with serial number: L-7233-76, showed that the crankcase was not damaged. None of the engine oil system components showed evidence of oil leak. The engine oil level was checked using a dipstick, and it contained adequate oil.

1.16.1.2 After the teardown inspection, the AMO reported that the crankshaft had broken into two halves at the Number 4 connecting rod journal. Evidence could not establish why the crankshaft broke.

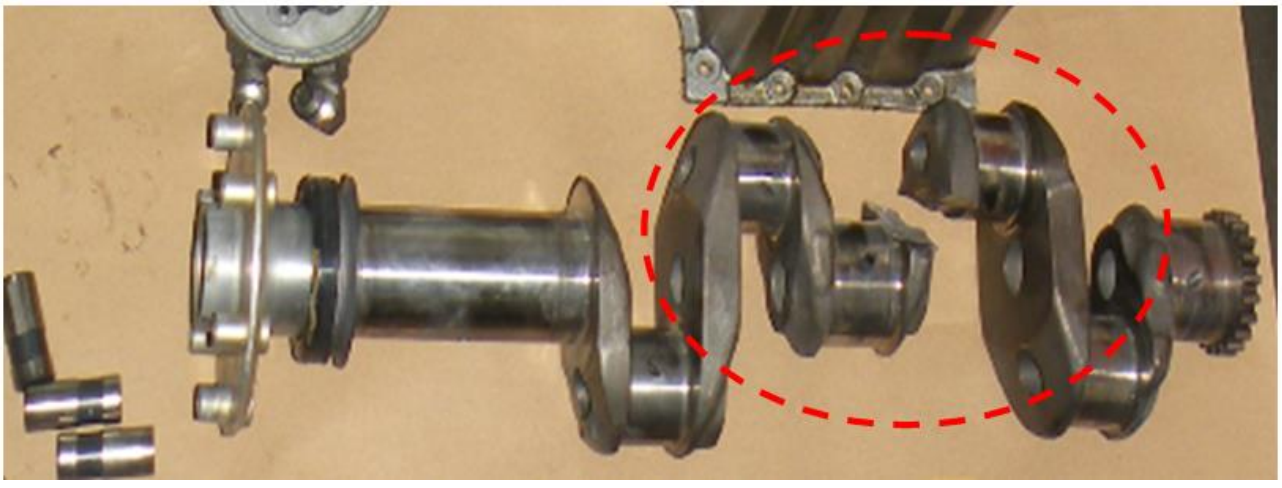


Figure 2: The crankshaft showing the area where the failure occurred.

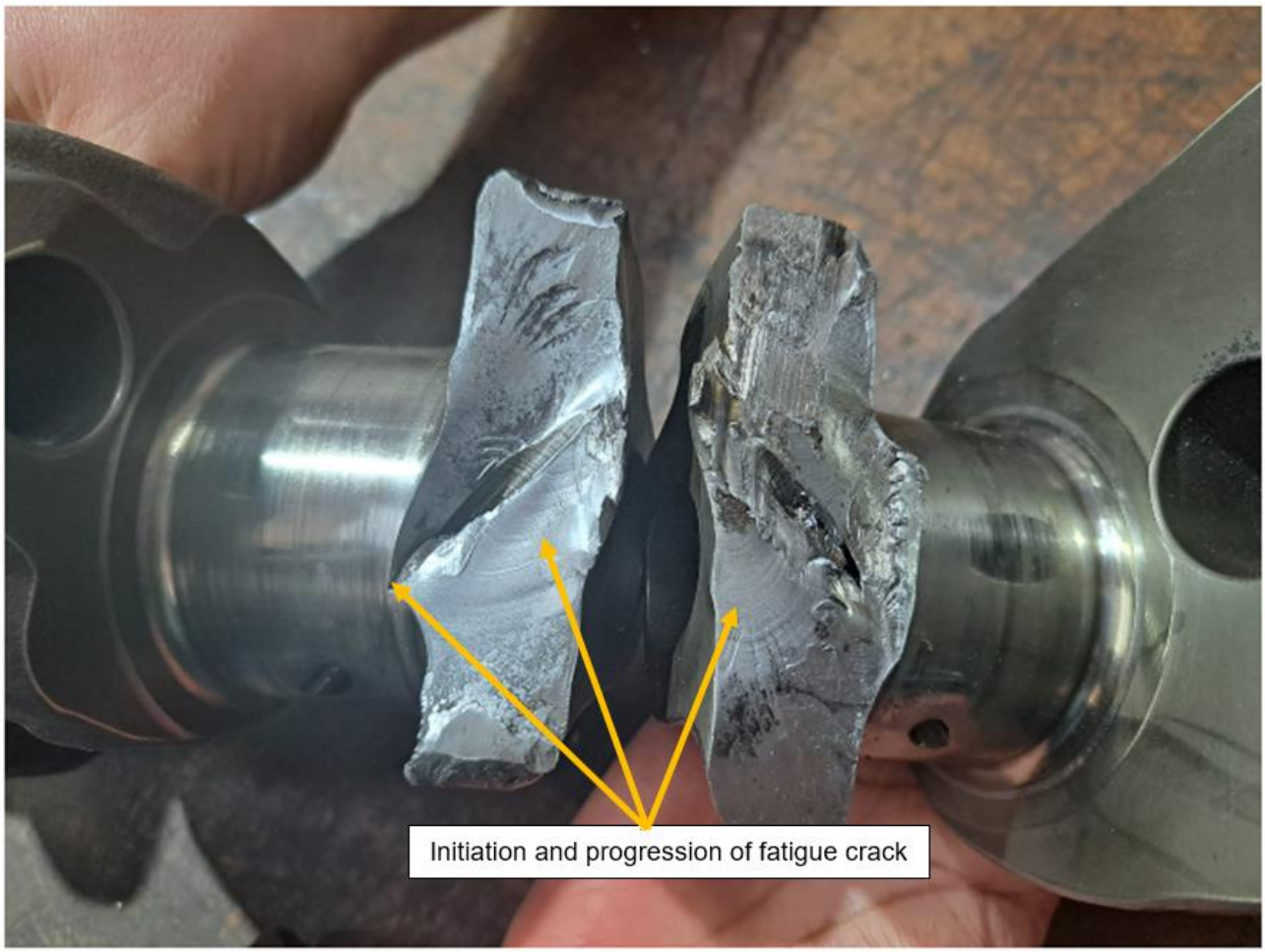
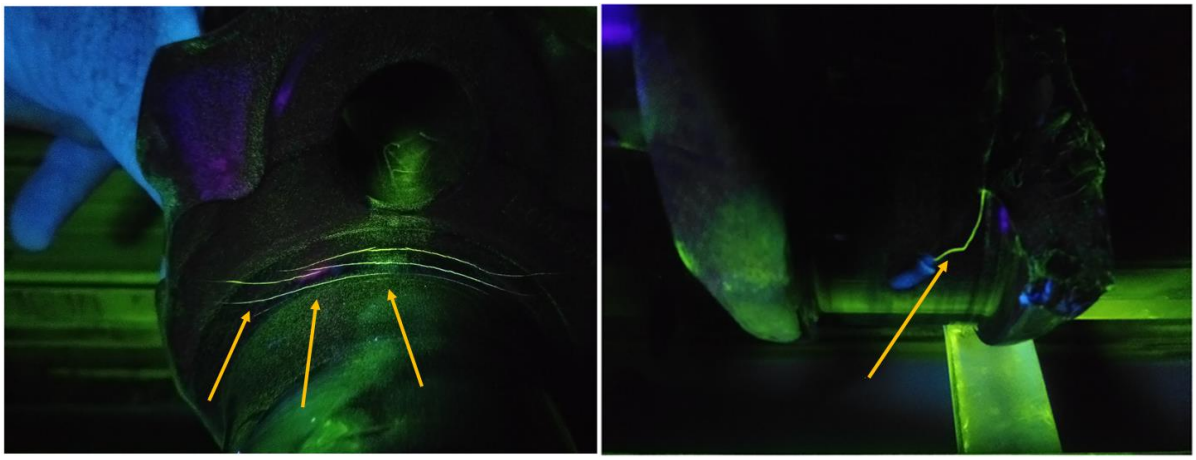


Figure 3: Front view of the crankshaft's fatigue crack initiation and progression.

1.16.1.3 Fatigue cracks initiated at the transition between the Number 4 connecting rod journal surface and the fillet of the crankarm, between the Number 3 and Number 4 connecting rod journals. The region where the fatigue fracture occurred was affected by localised deformations which are distinctive fatigue progression marks that are 'steplike' and extend from the site of initiation to the surface. These marks are created by major changes in the alternating loading spectrum. The magnetic particle inspection was conducted on 12 December 2019, and no cracks were detected during that inspection. According to the engine documentation, the aircraft was flown for approximately 1 047.1 hours since the last magnetic particle inspection. It was estimated that the fatigue crack had initiated and progressed over a period of at least 19 months.

1.16.1.4 The AMO also reported that the crankshaft had also snapped, and when it was magnafluxed it was found that there were various cracks on the radius. *Magnaflux is a process in which a solution containing iron powder is sprayed over the area where the crack initiated, in this instance, the broken crankshaft. Iron powder would settle inside the cracks. The powder would then be visible when an ultraviolet black light is shined on the area to identify the cracks.*



Figures 4 and 5: Post-accident pictures showing the initiation site and marks of fatigue crack progression.

1.16.2 Source – Lycoming Overhaul Manual, Revised January 1971, Page 7-7

7-45. Crankshaft (Bearing Surfaces)
During overhaul of the crankshaft, the operator must determine if it has standard or undersize bearing journals, then proceed with its overhaul accordingly. Undersize crankshafts are identified by a code symbol stamped on the front of the flange as a suffix to the part number. In addition to the code symbols, the letters RN are stamped as a suffix to the serial number indicating the shaft has been renitrided. The code symbols are M03MP (main and crankpin journals 0.003-inch undersize), M03M (main bearing journals 0.003-inch undersize), M03P (crankpin bearing journals 0.003 inch undersize). If the maximum service limits are exceeded (Reference 501 or 502, Table of Limits) standard shafts may be polished to 0.003-inch undersize and fitted with 0.003-inch undersize bearing inserts. Renitrided 0.003-inch undersize shafts may be polished to 0.006-inch undersize and fitted with 0.006-inch undersize bearing inserts. Do not allow lathe speed to exceed 150 revolutions per minute (RPM) at any time during polishing operation.

1.16.3. Cyclic Loading and Fatigue (Y. Murakami, *Comprehensive Structural Integrity*, 2003)

Notch Effect - Effect of stress distribution at notch roots

It has been said that 80–90% of fracture accidents are caused by fatigue. Investigation indicate that almost 100% of these fractures start from the sites of stress concentrations at structural discontinuities such as holes, notches, shoulders, cracks, defects, and scratches (Nishida, 1992). Stresses at structural discontinuities are higher than at other places on structures because of stress concentration. The phenomenon of decrease in fatigue strength due to stress concentration is called the "notch effect."

1.17 Organisational and Management Information

1.17.1 This was a training flight conducted under the provisions of Part 141 of the Civil Aviation Regulations (CAR) 2011 as amended.

1.17.2 The flying school had an Approved Training Organisation (ATO) certificate that was issued on 31 March 2021 with an expiry date of 31 March 2026.

1.17.3 The AMO that carried out the last maintenance inspection prior to the incident flight was in possession of an AMO approval certificate that was issued on 31 July 2021 with an expiry date of 31 July 2022.

1.18 Additional Information

1.18.1 Australian Transport Safety Board (ATSB) Aviation Research and Analysis Report- B20070191. The research focused on aircraft reciprocating engine failures. (Source: https://www.atsb.gov.au/media/29980/b20070191.pdf pg. 189-195, 213-214)

- ***Crankshaft fatigue fracture***
- ***Crankshaft design***
- ***Modification of journal fillet radius, surface initiation***

Example 7: *Lycoming IO-540-C4B5 engine, reported major defect 1995, crankshaft s/n 68499, connecting rod journals reduced in diameter by 0.003 of an inch by abrasive polishing.*

The fillets of all connecting rod journals had been notched, at the transition from the journal bearing surface to the crank web fillet, during the journal polishing process. Fatigue cracking initiated at the surface of the No.6 journal where the fillet had been notched.

Figure 8.93: Detailed view of the fatigue crack initiation site, crankweb side

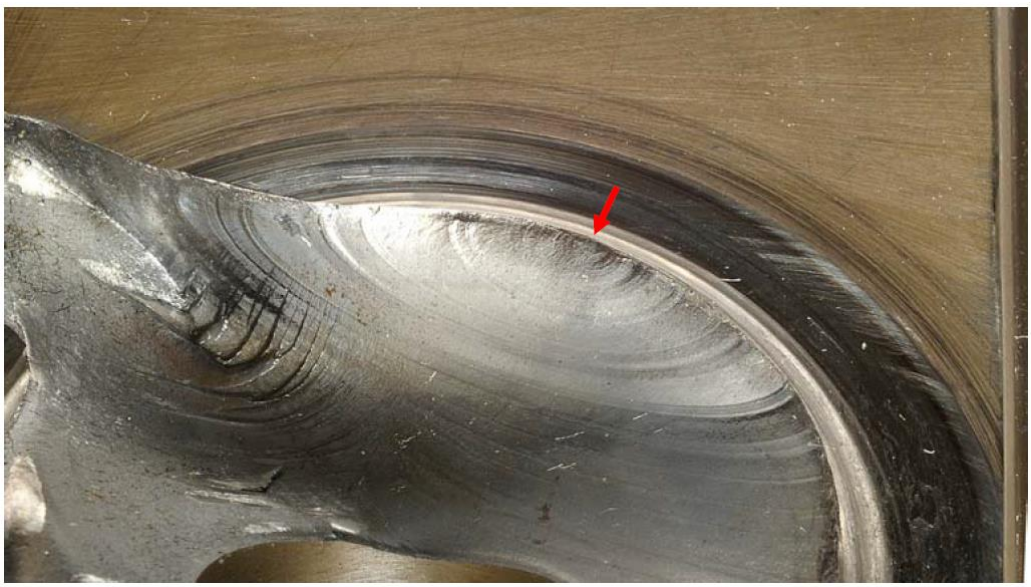
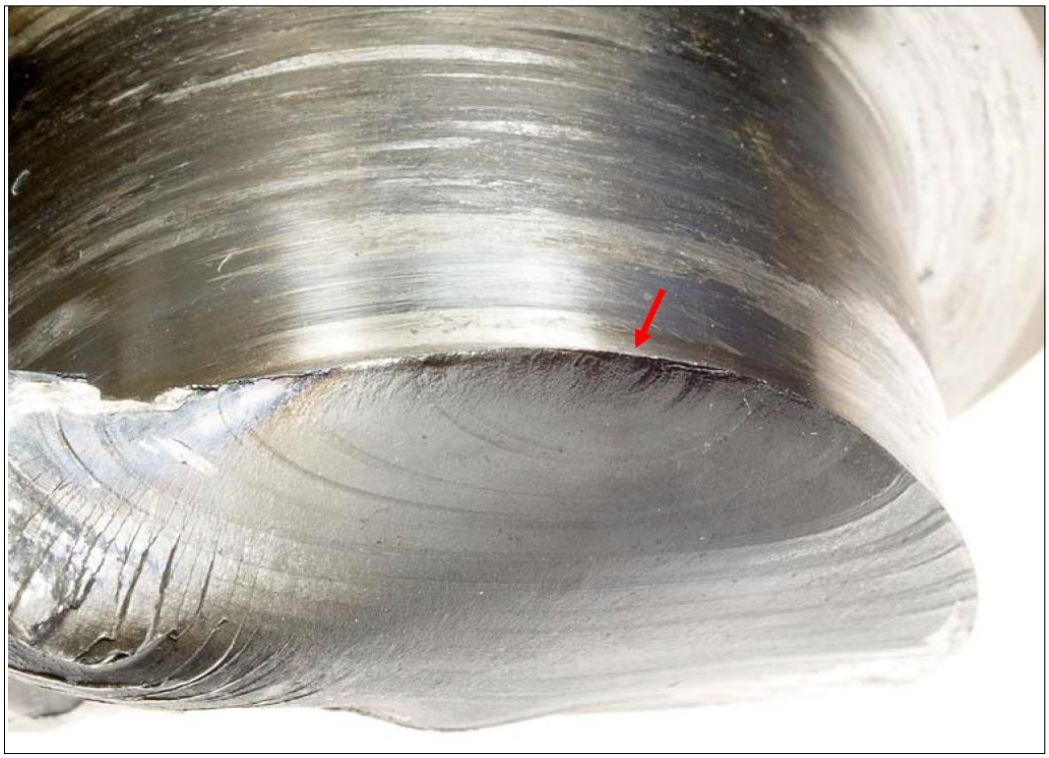


Figure 8.94: Detailed view of the fatigue crack initiation site, journal side



It is apparent, in this example, that while the site of fatigue initiation coincided with the predicted circumferential position of highest crankweb bending stress, the severe stress-concentrating feature created at the journal-to-fillet transition, during journal polishing, influenced the radial location of the initiation site in the fillet. The change in the site of crack initiation, with respect to the fillet, affected the plane of fatigue crack growth.

1.19 Useful or Effective Investigation Techniques

1.19.1 Not applicable.

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 instructor was issued a Commercial Pilot Licence (CPL) on 10 February 2021 with an expiry date of 28 February 2022. The instructor was also issued a Class 1 aviation medical certificate on 14 December 2020 with an expiry date of 14 December 2025.

2.2.2 The student pilot was initially issued a Student Pilot Licence (SPL) on 31 July 2021 with an expiry date of 30 July 2022. The student pilot was issued a Class 1 aviation medical certificate on 26 June 2021 with an expiry date of 30 June 2022. This was a training flight conducted under Part 141 of the CAR 2011 as amended.

2.2.3 According to available information, the aircraft was hard landed on 17 March 2020, three months after the last engine overhaul. This resulted in damages to the lower fire wall and the wing tip; the propeller was intact as it did not strike the ground during this incident.

2.2.4 The engine was last overhauled on 12 December 2019. According to the AMO records and engine logbook, the crankshaft was measured to be M0.003 inches undersize on the main journals and conrod journals. The corresponding bearings, M03-inch, were ordered on 25 November 2019 and were fitted to the crankshaft journals. The AMO only polished the journals to accommodate the engine assembly. The engine (aircraft) was operated for a further 1 047.1 hours since the last overhaul.

2.2.5 According to the Australian Transport Safety Board (ATSB) Aviation Research and Analysis Report: "*The fillets of all connecting rod journals had been notched at the transition from the journal bearing surface to the crank web fillet during the journal polishing process. Fatigue cracking initiated at the surface of the No.6 journal where the fillet had been notched."* It is possible that during the polishing of the journal, several small cracks developed and progressed over time, resulting in the failure of the crankshaft.

2.2.6 A comparison of the broken crankshaft between the ATSB Aviation Research and Analysis Report (Figures 8.93 and 8.94) and the incident aircraft crankshaft (Figures 4 and 5) show that both fatigue cracks initiated at the transition from the journal bearing surface to the crank web fillet, where it is most likely that a notch could have been introduced during the journal polishing process. Although the hours accumulated by the engines in example 7 and the incident aircraft engine are different, both the engine journals had undergone a type of material reduction process (polishing during their last overhaul).

2.2.7 The investigation established that the engine failure during the flight was due to the engine crankshaft that broke into two halves at the Number 4 piston connection rod journal area due to fatigue cracks initiated by a notch at the transition from the journal bearing surface to the crank web fillet.

3 CONCLUSION

3.1. General

From the available evidence, the following findings, causes and contributing factors were made with respect to this incident. 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 incident. The findings are significant steps in this incident sequence, but they are not always causal or indicate deficiencies.
- **Causes** — are actions, omissions, events, conditions or a combination thereof, which led to this incident.
- **Contributing factors** — are actions, omissions, events, conditions or a combination thereof, which, if eliminated, avoided or absent, would have reduced the probability of the incident occurring, or would have mitigated the severity of the consequences of the incident. 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 instructor was initially issued a SPL on 14 November 2019 with an expiry date of 13 November 2020. He was also issued a PPL on 18 March 2020 with an expiry date of 31 March 2021. At the time of the incident, the instructor had a CPL issued on 10 February 2021 with an expiry date of 28 February 2022.

3.2.2 The instructor was issued a Class 1 aviation medical certificate on 14 December 2020 with an expiry date of 14 December 2025.

3.2.3 The student pilot was initially issued a SPL on 31 July 2021 with an expiry date of 31 July 2022.

3.2.4 The student pilot was issued a Class 1 aviation medical certificate on 30 June 2021 with an expiry date of 30 June 2022.

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3.2.5 The aircraft was initially issued a Certificate of Airworthiness (CoA) on 20 August 2010. The aircraft's latest CoA had an expiry date of 31 August 2022 (at the time of this incident). The current owner of the aircraft was issued a Certificate of Registration (CoR) on 15 September 2016.

3.2.6 The aircraft was issued a Certificate of Release to Service (CRS) on 2 July 2021 with an expiry date of 2 July 2022 or at 13 625.4 airframe hours, whichever occurs first.

3.2.7 The last 100hr/1-year MPI was carried out on 2 July 2021 at 13 624.8 airframe hours. The aircraft had accumulated an additional 87 airframe hours in operation since the last MPI.

3.2.8 The flight was conducted under the provisions of Part 141 of the Civil Aviation Regulations (CAR) 2011 as amended. The crew was engaged in a training flight at the time of the incident.

3.2.9 The AMO that carried out the last maintenance inspection on the aircraft prior to the incident flight was in possession of an AMO approval certificate that was issued on 22 July 2021 with an expiry date of 31 July 2022.

3.2.10 The last overhaul was carried out on 12 December 2019 at 4 617.7 total engine hours. The aircraft was flown a further 1 047.1 hours. The engine had a total of 5 664.8 hours at the time of the incident.

3.2.11 The aircraft was involved in an accident on 17 March 2020 where it sustained damages to the lower fire wall and the wing tip; the propeller was not damaged during the accident sequence. It was determined that the propeller did not contribute to this incident.

3.2.12 It is possible that the polishing process carried out during the last overhaul introduced a notch at the transition from the journal bearing surface to the crank web fillet which was the initiation point of the fatigue crack that led to the failure of the crankshaft.

3.2.13 The investigation established that the engine failure during the flight was a result of a crankshaft that broke into two halves at the Number 4 piston connecting rod journal area due to fatigue cracks.

3.3. Probable Cause

3.3.1 In-flight engine stoppage as a result of a failed crankshaft that broke into two halves at the Number 4 piston connecting rod journal area due to fatigue. This was followed by a successful forced landing.

3.4 Contributing factor

3.4.1. Polishing of the connecting rod journal possibly introduced a notch (material weakness) during the engine's last overhaul.

4 SAFETY RECOMMENDATIONS

4.1. General

The safety recommendations listed in this report are proposed according to paragraph 6.8 of Annex 13 to the Convention on International Civil Aviation and are based on the conclusions listed in heading 3 of this report. The AIID expects that all safety issues identified by the investigation are addressed by the receiving States and organisations.

4.2. Safety Recommendation/s

4.2.1 None.

5 APPENDICES

5.1 Annexure A

This report is issued by:

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

Annexure A

Paste copies of engine maintenance history here see note at (5) to the CRMA

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CIVIL AVIATION AUTHORITY

AUTHORISED RELEASE CERTIFICATE

CA-21-19 AIRWORTHINESS APPROVAL TAG

Form Tracking Number: CLK 1308

4. Organization Name and Address: Clack Air cc, Hangar No 4 North, Springs Airfield, Gauteng
Tel: +27 (0) 11 817 2562
Fax: +27 (0) 86 654 2172
Web Address: www.clackair.co.za
Email: brian@clackair.co.za

5. Work Order/Invoice: CLK 1308

6. Registration No.	7. Description	8. Part Number	9. Eligibility *	10. Quantity	11. Serial No.	12. Status / work
ZS-	ENGINE	O-320-H2AD	LYCOMING	1	L-7233-76	OVERHAUL

13. Remarks. ***NOTE: SERVICEABLE STD CYLINDERS, MAIN BEARINGS AND CONROD BEARINGS M03, NEW CAMSHAFT AND LIFTERS***
THE ENGINE WAS STRIPPED, CLEANED AND OVERHAULED IN ACCORDANCE WITH LYCOMING OVERHAUL MANUAL 60294-7-14 REVISED JULY 2011.
THE FOLLOWING TECHNICAL REQUIREMENTS WERE COMPLIED WITH S.B, 238 MAGNATIZED HYDRAULIC PLUNGERS; 240W MANDATORY REPLACEMENT PARTS; 271A CYLINDER PAINTING; 472 DISSASSEMBLY WIDE CYLINDER FLANGE CRANKCASE; 630A CONROD BUSH INSP; 632B IDENT OF CONROD ; SI1029D TIGHTENING THROUGH STUDS; SI1037 PISTON AND RING APPLICATION; SI1059C PRE-LUBRICATIONPARTS PRIOR TO ASSEMBLY; SI1060 PUSH ROD IDENT; SI1125D ALTERNATE SEALANT; SI1181 COLOUR CODE CYLINDERS; 1204D EXH FLANGE GASKET; SI1205 CRANKSHAFT JOURNAL STANDARDS; SI1277 SHROUD TUBE RETAINING; SI1324C CRANKSHAFT OIL SEAL; SI1418 COMBUSTION CHAMBER CLEANING; SI1424A INSTALLATION OF HYD TAPPET PLUNGERS; SI1483 VALVE LEAK CHECK; SI1487 OIL DRAIN TUBE CLEARANCE; SI1508C DUAL MAG ATTACHMENT; 1558 NEW PISTON RING PART NUMBER;
THE FOLLOWING TECHNICAL REQUIREMENTS WERE FOUND COMPLIED WITH:
301B VALVE SERVICE LIMITS; 439A CONROD GAULING; S8524 OIL PUMP IMPELLERS; 543C OIL FILTER PLATE GASKET; 619 HARDNESS CHECK ROCKER ARM; SI1047 INSP OF CRANKSHAFT; SI1106 CONROD NUT CRIMP; SI1123D O'RINGS AT THROUGH STUDS; SI1135A HEAD INSP; SI1173 IND PIPE STUDS; SI1243PISTON IDENT; 1256F VALVE GUIDE SERVICE USE; 1285E NDT ENGINE; 1307B CONROD TORQUE; SI1406E LARGE DIAMETER LIFTERS; SI1458 CONROD BOLTS;
THE FOLLOWING A.D.'s WERE FOUND COMPLIED WITH:
THE FOLLOWING A.D.'s WERE COMPLIED WITH: 77-20-07 ROCKER RETAINING NUTS; 2002/12/07 PREVENT OIL LOSS;

All work pertaining this job is held at Clack Air under Job No. CLK 1300

14. Certifies the items identified above were manufactured I conformity to:
☐ Approved design data and are in condition for safe operation.
☐ Non-approved design data specified in block 13.

19. ☒ Part 43 Release to service ☐ Other regulation specified in block 13
Certifies that unless otherwise specified in block 13, and the work identified in block 12 and described in block 13 was accomplished in accordance with Civil Aviation Regulations, part 43 and in respect to that work, the items are approved for return to service.

15. Authorised Signature	16. Approval/Authorization No.	20. Authorised Signature	21. Certificate/Approval Ref. No.
			CLACK AIR AMO 1207 INSP No 1
17. Name	**18. Date: (YY/MM/DD)**	**22. Name**	**23. Date: (YY/MM/DD)**
		B. A. Clack	12 DECEMBER 2019

User / Installer Responsibilities

It is important to understand that the existence of this document alone does not automatically constitute authority to install the part/component/assembly.

Where the user/installer performs work with the national regulations of an airworthiness authority different than the airworthiness authority of the country specified in Block 1, it is essential that the user/installer ensures that his/her airworthiness authority accepts parts/components/assemblies from the airworthiness authority of the country specified in Block 1.

Statements in Block 14 and 19 do not constitute installation certificate. In all cases, aircraft maintenance records must contain an installation certification issued in accordance with the national regulations by the user/installer before