AIRCRAFT ACCIDENT REPORT AND EXECUTIVE SUMMARY

				Reference:		CA18/2/3/10380	
Aircraft Registration	ZT-RBU	**Date of Accident**		26 October 2023		**Time of Accident**	0700Z
Type of Aircraft	Robinson R44, Raven II			**Type of Operation**		Private (Part 91)	
Pilot-in-command Licence Type	Commercial Pilot Licence (CPL)			**Age**	40	Licence Valid	Yes
Pilot-in-command Flying Experience		**Total Flying Hours**		9 848.2		**Hours on Type**	6 315
Last Point of Departure	Private Farm in Vaalwater, Limpopo Province						
Next Point of Intended Landing	Marataba Mountain Lodge in Thabazimbi, Limpopo Province						
Damage to Aircraft	Substantial						
Location of the accident site with reference to easily defined geographical points (GPS readings if possible)							
Bushy terrain, approximately 170 metres west of Marataba Mountain Lodge in Thabazimbi, Limpopo Province, at GPS position determined to be 24°20'44.1" South 027°29'41.5" East, at an elevation of 3 349 feet							
Meteorological Information	Wind direction: Calm; Wind speed: Calm; Air Temperature: 19°C; Dew Point: 09°C						
Number of People On-board	1+1	**Number of People Injured**	0	**Number of People Killed**	0	**Other (On Ground)**	0

Synopsis

On Thursday morning, 26 October 2023, a pilot and a passenger on-board a Robinson R44 Raven II helicopter with registration ZT-RBU took off from a private farm in Vaalwater, Limpopo province, to Marataba Mountain Lodge in the same province. The flight was conducted under visual meteorological conditions (VMC) by day and under the provisions of Part 91 of the Civil Aviation Regulations (CAR) 2011 as amended.

The pilot stated that during final approach for landing at Marataba Mountain Lodge at 50 feet (ft) above ground level (AGL), the engine lost power. The low rotor revolutions per minute (RPM) warning light illuminated and the warning horn sounded. Thereafter, the helicopter entered an uncontrolled descent and impacted the ground hard with the landing gear skids. During the impact sequence, the main rotor blades severed the tail boom. The helicopter rolled to the right and came to rest on its right side. The helicopter sustained substantial damage; the occupants were not injured.

After the accident, the wreckage was recovered to the aircraft maintenance organisation (AMO) at Springs Aerodrome (FASI) in Gauteng province where the engine, a Lycoming IO-540-AE1A5 with serial number L31394-48A, was removed and subjected to a teardown inspection. The inspection revealed that the idler gear shaft flange bolt hole had fractured. The idler gear shaft flange material and hardness conformed to Lycoming standards. The failed idler gear and fasteners (bolts and nuts) were sent to the engine manufacturer (Lycoming), and the failed flange bolt was subjected to a microscopic analysis. The root cause of the failure was determined to be fatigue, which its origin was unknown.

Probable Cause and Contributory Factor			
During the final approach for landing at Marataba Mountain Lodge in Limpopo province, the engine lost power, consequently, the helicopter entered an uncontrolled descent which resulted in a hard landing with the landing gear skids. Contributing Factor The flange bolt that secured the idler gear failed due to fatigue; the origin of the fatigue was unknown.			
SRP Date	11 March 2025	Publication Date	11 March 2025

Occurrence Details

Reference Number	**:** CA18/2/3/10380
Occurrence Category	**:** Category 1
Type of Operation	**:** Private (Part 91)
Name of Operator	**:** West Dunes Aviation (PTY) LTD
Helicopter Registration	**:** ZT-RBU
Aircraft Make and Model	**:** Robinson R44, Raven II
Nationality	**:** South African
Place	**:** Bushy terrain, approximately 170m west of Marataba Mountain Lodge
Date and Time	**:** 26 October 2023 at 0700Z
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) was notified of the occurrence on 26 October 2023 at 0730Z. 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. Notification was sent to the State of Registry, Operator, Design and Manufacturer in accordance with the CAR 2011 Part 12 and the ICAO Annex 13 Chapter 4. The States did not appoint an accredited representative and advisor. The investigators did not dispatch 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 Robinson R44, Raven II 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
ACCID	Accident
AGL	Above Ground Level
AIID	Accident and Incident Investigations Division
AMO	Aircraft Maintenance Organisation
CAR	Civil Aviation Regulations
CAVOK	Cloud and Visibility Ok
C of A	Certificate of Airworthiness
C of R	Certificate of Registration
CPL	Commercial Pilot Licence
CRS	Certificate of Release to Service
CVR	Cockpit Voice Recorder
FDR	Flight Data Recorder
FASI	Springs Aerodrome
Ft	Feet
GPS	Global Positioning System
hPa	Hectopascal
Kt	Knots
L	Litres
M	Metres
METAR	Meteorological Aerodrome Report
PIC	Pilot-in-command
POH	Pilot's Operating Handbook
QNH	Barometric Pressure Adjusted to Sea Level
RPM	Revolutions Per Minute
SACAA	South African Civil Aviation Authority
SAWS	South African Weather Service
TBO	Time Between Overhaul
UTC	Co-ordinated Universal Time
VFR	Visual Flight Rules
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 Thursday morning, 26 October 2023, a pilot and a passenger on-board a Robinson R44 Raven II helicopter with registration ZT-RBU took off on a private flight from a farm in Vaalwater to Marataba Mountain Lodge, both located in Limpopo province. Clear weather conditions prevailed at the time of the flight. The flight was conducted under visual meteorological conditions (VMC) by day and under the provisions of Part 91 of the Civil Aviation Regulations (CAR) 2011 as amended.

1.1.2. The pilot stated that he conducted a pre-flight inspection of the helicopter and nothing abnormal was found. The helicopter was refuelled to maximum capacity, which is 180 litres (L) of Avgas 100LL. After the passenger had boarded the helicopter, the pilot started the engine and allowed it to warm up until all the instruments were within the normal operating range (green arch) with positive fuel flow. Later, the pilot lifted off and routed to Marataba Mountain Lodge. After 24 minutes of flight time, the helicopter arrived at Marataba Mountain Lodge and the pilot circled the area to identify the landing zone. The pilot also observed the windsock to determine the wind direction; he concluded that the wind was blowing from the east. Thereafter, he commenced with the approach into wind (westerly) at an indicated airspeed of approximately 45 knots (kts).

1.1.3. During final approach at approximately 50 feet (ft) above ground level (AGL), the engine lost power; the low rotor revolutions per minute (RPM) warning light illuminated and the warning horn sounded. The helicopter entered an uncontrolled descent and impacted the ground hard with its landing gear skids. During this process, the main rotor blades severed the tail boom. The helicopter rolled to the right and came to rest on its right side. The helicopter sustained substantial damage; however, the occupants were not injured.

1.1.4. The accident occurred during daylight at Global Positioning System (GPS) co-ordinates determined to be 24°20'44.51" South 027°29'41.89" East, at an elevation of 3 349 feet (ft).

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 helicopter sustained substantial damage. The landing gear skids were broken and detached from the fuselage; the main rotor blades and the main rotor pitch change links were damaged on impact; the tail boom was severed, and the tail rotor was dislodged.

Figure 1: The helicopter at the accident site. (Source: Pilot)

1.4. Other Damage

1.4.1. None.

1.5. Personnel Information

Pilot

Nationality	South African	Gender	Male	Age	40
Licence Type	Commercial Pilot Licence (CPL)				
Licence Valid	Yes	Type Endorsed	Yes		
Ratings	None				
Medical Expiry Date	31 August 2024				
Restrictions	Corrective lenses for defective vision (VDL)				
Previous Accidents	None				

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

Flying Experience:

Total Hours	9 848.2
Total Past 24 Hours	4.0
Total Past 7 Days	6.1
Total Past 90 Days	119.7
Total on Type Past 90 Days	19.1
Total on Type	6 315

1.5.1. The pilot was initially issued a Commercial Pilot Licence on 13 August 2004. The licence was renewed on 26 January 2023 with an expiry date of 31 February 2024. The pilot had flown a total of 9 848.2 hours of which 6 315 hours were on the helicopter type. The helicopter type was endorsed on his licence and logbook.

1.5.2. The pilot was issued a Class 1 aviation medical certificate on 25 August 2023 with an expiry date of 31 August 2024 with a medical waiver (correction for defective distant vision). The pilot was properly licensed to conduct the flight and was medically fit in accordance with Part 67 of the CAR 2011 as amended.

1.6. Aircraft Information

Airframe:

Manufacturer/Model	Robinson Helicopter Company / R44 Raven II	
Serial Number	11359	
Year of Manufacture	2006	
Total Airframe Hours (At Time of Accident)	2 151.5	
Last Inspection (Date & Hours)	30 May 2023	2 135.3
Airframe Hours Since Last Inspection	16.2	
CRS Issue Date	30 May 2023	
C of A (Issue Date & Expiry Date)	16 March 2023	31 March 2024
C of R (Issue Date) (Present Owner)	7 February 2017	
Operating Category	Part 91	
Type of Fuel Used	Avgas 100LL	
Previous Accidents	None	

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

Engine:

Manufacturer/Model	Lycoming / IO-540-AE1A5
Serial Number	L31394-48A
Hours Since New	2483.6
Hours Since Overhaul	330

1.6.1. According to the engine logbook, the engine was installed on ZT-RBU on 13 February 2017 at 554.9 hours.

1.6.2. On 9 December 2021, the engine was removed from ZT-RBU at 2 153.4 hours and was subjected to a 2 200 time between overhaul (TBO) maintenance inspection at the engine overhaul facility at Springs Aerodrome (FASI) in Gauteng province. During maintenance, the engine was dismantled and reassembled using the new parts approved by the manufacturer (Lycoming).

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 for Thabazimbi Aerodrome (FATH) on 26 October 2023 between 0400Z and 0600Z. FATH is located 14 nautical miles from the accident site.

FATH 260500Z AUTO 00000KT //// // ////// 19/09 Q1023 =

Wind Direction	Calm	Wind Speed	Calm	Visibility	9999m
Temperature	19°C	Cloud Cover	Unknown	Cloud Base	Unknown
Dew Point	09°C	QNH	1023 hPa		

1.7.2. Satellite Image

The satellite imagery at 0500Z (below) indicates that there was no significant weather prior to the flight. The satellite image shows no significant clouds.

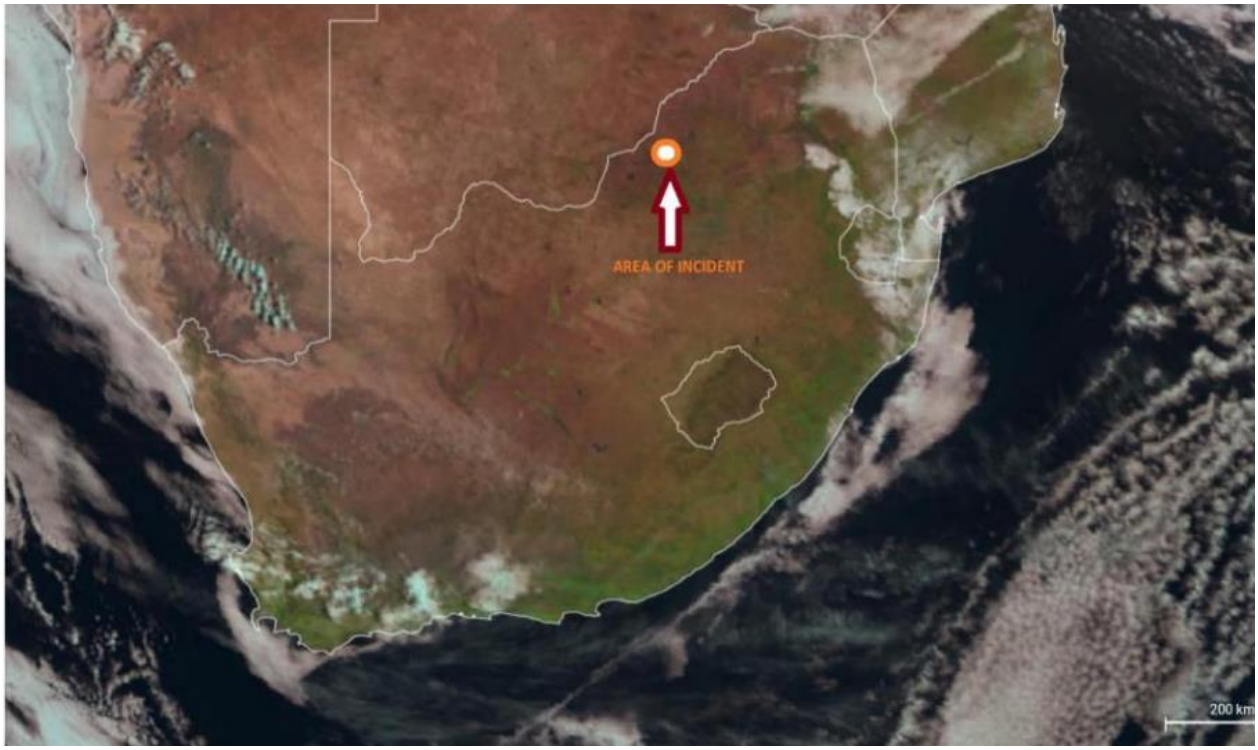


Figure 2: The day natural colours imagery. (Source: EumetSat)

1.8. Aids to Navigation

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

1.9. Communication

1.9.1. The helicopter 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 on a bushy terrain, approximately 170 metres (m) west of Marataba Mountain Lodge in Thabazimbi, Limpopo province at GPS co-ordinates determined to be 24°20’44.1” South 027°29'41.5” East, at an elevation of 3 349 feet.

1.11. Flight Recorders

1.11.1. The helicopter 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 helicopter type.

1.12. Wreckage and Impact Information

1.12.1. The accident occurred on a bushy terrain, approximately 170 metres (m) west of Marataba Mountain Lodge. The helicopter was found lying on its right side. The aft section of the tail boom was severed, indicating an impact that was consistent with contact with the main rotor. The helicopter’s landing skids were detached, this damage aligned with the hard landing sequence. Both main rotor blades exhibited significant bending, which was consistent with low rotor RPM as they impacted the ground.

Figure 3: The helicopter at the accident site with broken landing gear skids. (Source: Pilot)

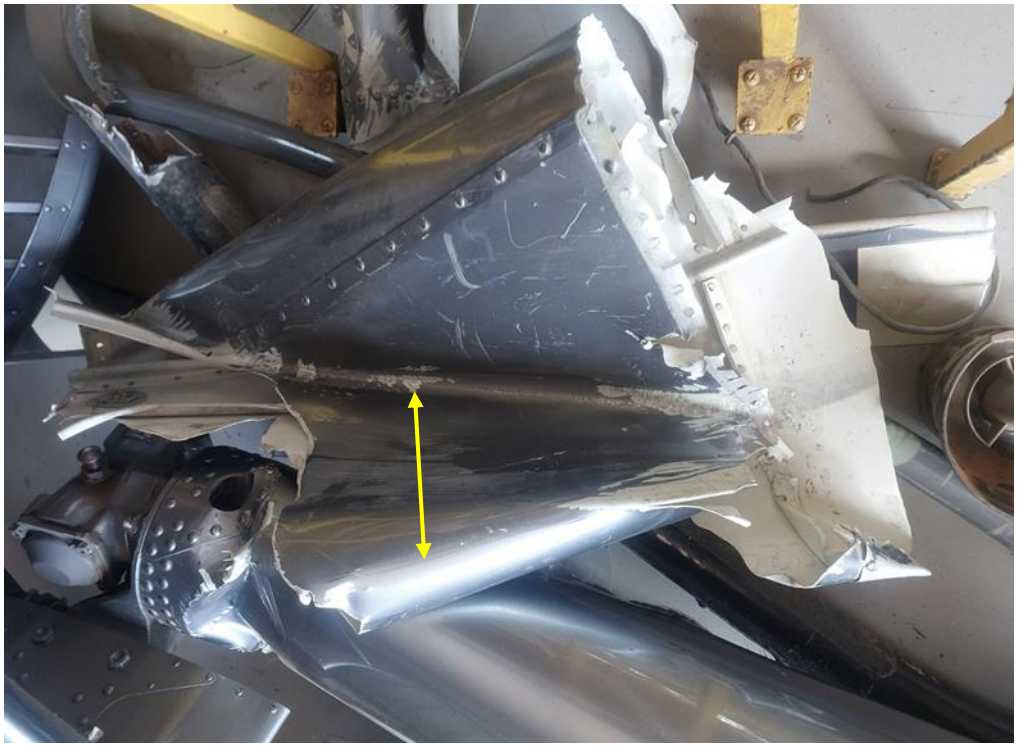


Figure 4: Imprint of the main rotor blade strike on the tail boom section.

Figure 5: The detached tail rotor.

1.13. Medical and Pathological Information

1.13.1. None.

1.14. Fire

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

1.15. Survival Aspects

1.15.1. The accident was considered survivable as the cockpit structure sustained minor damage on impact. The pilot and the passenger had also made use of the helicopter's safety harnesses.

1.16. Tests and Research

1.16.1 The engine was recovered to the SACAA-approved engine overall facility at Springs Aerodrome (FASI) and was subjected to a teardown inspection. The aircraft maintenance organisation (AMO) discovered that the idler gear shaft flange fractured on the flange bolt hole. The idler gear drives the camshaft gear and magneto, it is considered an on-condition item. The failed idler gear and fasteners (bolts and nuts) were sent to the engine manufacturer (Lycoming) in the United States of America (USA) for assessment. The idler gear shaft flange material and hardness conformed to Lycoming standards.

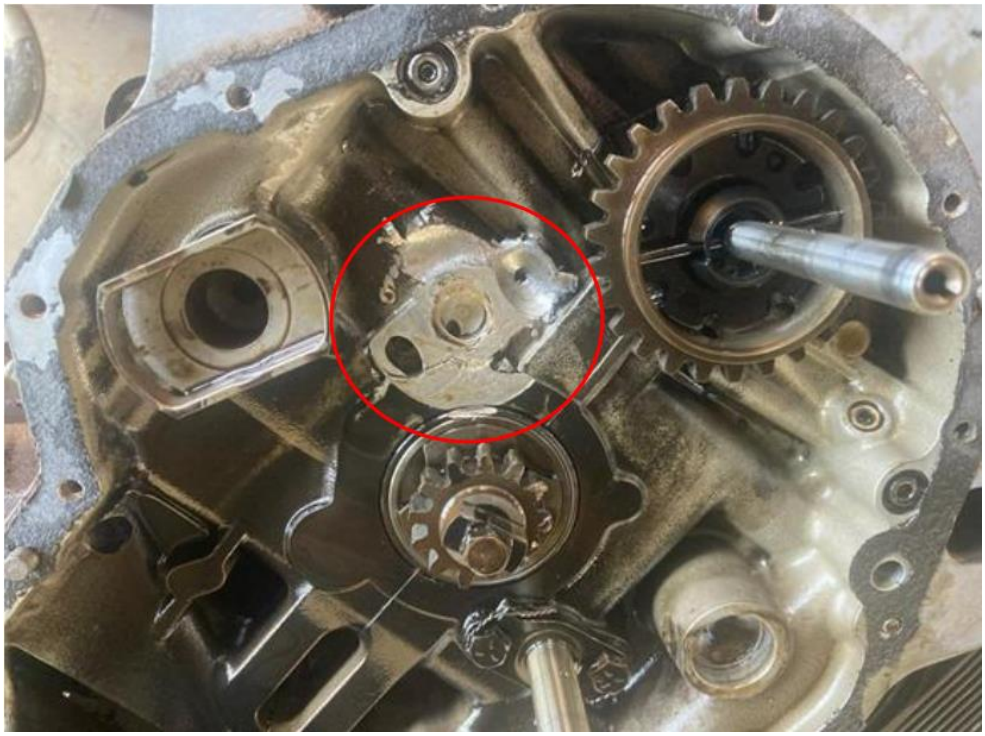


Figure 6: The failed idler gear location circled in red.

Figure 7: The idler gear shaft fractured on the flange bolt hole.

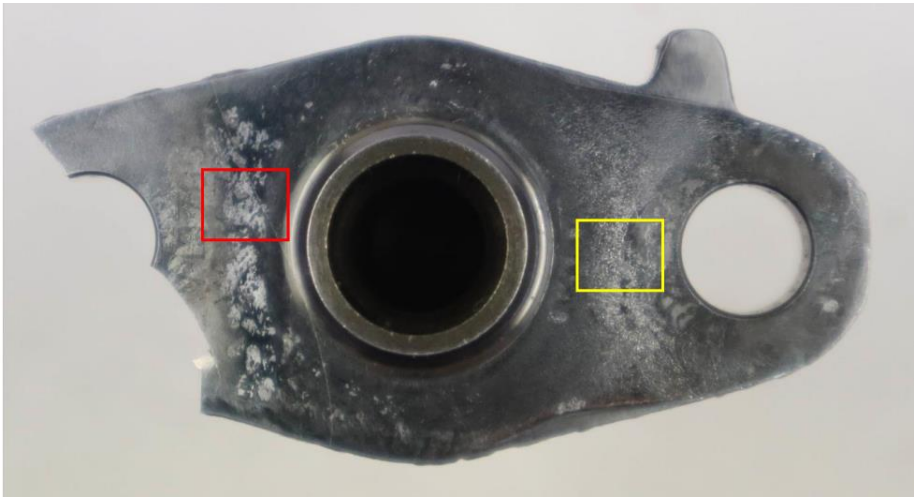


Figure 8: The red and yellow squares show wear on the idler gear shaft flange.

1.16.2 The fasteners that secured the shaft flange were not marked or identified before they were sent to the engine manufacturer; they were both assumed to be 01A23354 studs with STD-2168 castellated nuts and LW-31H0.88 bolts. The location of the fasteners in relation to the broken flange was unknown. One of the two bolts was fractured. Studs on both bolts were severely altered by wear. The non-fractured fastener had a castellated nut still attached to it.

Figure 9: The fasteners that secured the flange; one fastener is fractured and other one is intact. Both were severely altered by wear.

Figure 10: A castellated nut was still attached to the non-fractured fastener.

Figure 11: A used stud (left) and a new 01A23354 stud (right).

1.16.3 The failed flange bolt was subjected to a microscopic analysis and the root cause of its failure was determined to be fatigue; the origin of the fatigue was unknown. It was also not determined which failed first between the idler gear shaft flange and the bolt that secured it.

Figure 12: The fractured bolt compared to a new LW-31H0.88 bolt.

1.17. Organisational and Management Information

1.17.1. The flight was conducted in accordance with the provisions of Part 91 of the CAR 2011 as amended.

1.17.2. The helicopter was registered to the current owner on 7 February 2017.

1.17.3. The AMO which maintained the helicopter had a valid AMO Certificate that was issued on 3 November 2022 with an expiry date of 30 November 2023.

1.18. Additional Information

1.18.1 The engine overhaul guidance in accordance with Lycoming mandatory Service Bulletin (SB):

AT OVERHAUL OR UPON REMOVAL:

Any time the following parts are removed from any Lycoming reciprocating engine, it is mandatory that the following parts be replaced regardless of their apparent condition:

- All circlips, lockplates, retaining rings and laminated shims
- All counterweight washers
- All lockwashers and locknuts
- All main and connecting rod bearings (may also be referred to as "bearing inserts")
- All V-band coupling gaskets
- Stressed bolts and fasteners, such as:
  - Stationary drive gear bolts (reduction gear)
  - Camshaft gear attaching bolts
  - Connecting rod bolts and nuts
  - Crankshaft flange bolts
  - Crankshaft gear bolt

AT OVERHAUL:

During overhaul of any Lycoming reciprocating engine, it is mandatory that the following parts be replaced regardless of their apparent condition:

- All engine hoses
- All engine hose assemblies
- All oil seals
- All cylinder base seals
- All gaskets
- Piston rings
- Piston pins (thin wall)*
- Piston pin plugs
- Propeller governor oil line elbow (aluminum)**
- Propeller shaft sleeve rings
- Propeller shaft rollers (reduction gear pinion cage)
- Propeller shaft thrust bearings (all geared drive engines)
- Supercharger bearing oil seal (mechanically supercharged series)
- All exhaust valves (replace with current exhaust valves)
- All intake and exhaust valve guides
- All exhaust valve retaining rings
- Rocker arms and fulcrums (O-320-H, O, LO, TO, LTO-360-E Series)
- Aluminum push rod assemblies ● (O-235 Series)
- Cylinder fin stabilizers
- Magneto drive cushions
- Magneto isolation drive bearings
- Thermostatic bypass valves
- Damaged ignition cables
- Crankshaft sludge tubes
- Counterweight bushings in crankshaft and in counterweights (See latest revision of Service Instructions No. 1142 and 1143 for instructions.)
- Accessory drive coupling springs (supercharged and VO-540 engines)
- AC diaphragm fuel pumps
- Fuel pump plunger for diaphragm fuel pumps
- Oil pump bodies (two-piece)
- Oil pump gears *** (Refer to the latest revision of Service Bulletin No. 524 for replacement gear service kit, if necessary, and Service Instruction No. 1164 for individual impeller part numbers.)
- All V-band couplings and gaskets
- Roller tappet assemblies ■
- Hydraulic tappet plunger assemblies♦

Requirements for replacement of parts for accessories such as magnetos, carburetors, fuel injectors, AN fuel pumps, and turbochargers are described in the applicable manufacturer's manual.

* Heavy-wall piston pins P/N LW-14078 may be reused; all other may not be reused. See the latest revision of Service Instruction No. 1340 and No. 1267 for replacement data.

** P/N MS20822-6D aluminum propeller governor oil line elbow must be replaced with P/N MS20822-6 steel elbow at overhaul. It is not necessary to replace a steel elbow. See the latest revision of Service Instruction No. 1435 and Service Bulletin No. 488.

*** Nitrided/carburized steel oil pump impeller gears can be examined during overhaul and can be re-used if they pass inspection as per the latest revision of Lycoming Direct Drive Overhaul Manual 60294-7 and Table of Limits SSP-1776.

■ Roller tappet assemblies must be replaced at overhaul and after a propeller strike. See latest revision of Service Instruction Nos. 1011 and 1514 for instructions.

♦ Refer to the latest revision of Service Instruction No. 1011.

● Refer to the latest revision of Service Instruction No. 1480.

Carry out the dimensional inspections in accordance with measurements and tolerances as listed in "Table of Limits" (SSP-1776) for all parts approved for use.

1.18.2. The following information is an extract from the Robinson R44 Pilot's Operating Handbook (POH):

POWER FAILURE BETWEEN 8 FEET AND 500 FEET AGL

1. Lower collective immediately to maintain rotor RPM.
2. Adjust collective to keep RPM between 97 and 108% or apply full down collective if light weight prevents attaining above 97%.
3. Maintain airspeed until ground is approached, then begin cyclic flare to reduce rate of descent and forward speed.
4. At about 8 feet AGL, apply forward cyclic to level ship and raise collective just before touchdown to cushion landing. Touch down in level attitude and nose straight ahead.

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. Pilot

2.2.1.1 The pilot was initially issued a Commercial Pilot Licence (CPL) on 13 August 2004. The licence was renewed on 26 January 2023 with an expiry date of 31 February 2024. The pilot had flown a total of 9 748.4 hours of which 6 315 hours were on the helicopter type. The helicopter type was endorsed on his licence and logbook. Therefore, the pilot was qualified to undertake this flight.

2.2.1.2 The pilot was issued a Class 1 aviation medical certificate on 25 August 2023 with an expiry date of 31 August 2024 with a medical waiver (correction for defective distant vision). The pilot was properly licensed to conduct the flight and was medically fit in accordance with Part 67 of the CAR 2011.

2.2.1.3 The pilot was able to conduct an autorotational flight after the engine had failed, which was in line with the emergency procedure in the Robinson R44 POH. However, the helicopter landed hard on the ground which contributed to the substantial damage of the helicopter.

2.2.2. Aircraft

2.2.2.1 The last mandatory periodic inspection (MPI) of the helicopter was conducted and certified on 30 May 2023 at 2 135.3 airframe hours. The helicopter had accrued 16.2 hours since the last MPI. The helicopter had a total of 2 151.5 hours since new. The maintenance was conducted in accordance with the Robinson R44 Maintenance Manual and procedures stipulated by the Regulator. Therefore, there were no maintenance issues prior to the flight.

2.2.2.2 The helicopter had a valid Certificate of Airworthiness (C of A) that was initially issued on 8 March 2017. The C of A was renewed on 16 March 2023 with an expiry date of 31 March 2024. The Certificate of Release to Service (CRS) was issued on 30 May 2023 with an expiry date of 24 May 2024 or at 2 235.3 hours, whichever comes first. Therefore, the helicopter was deemed airworthy to undertake the flight.

2.2.2.3 The Certificate of Registration (C of R) was issued to the present owner on 7 February 2017. There were no defects reported prior to the accident flight; therefore, the helicopter was considered airworthy at the time of the flight.

2.2.2.4 The engine underwent an engine overhaul at the engine facility at Springs Aerodrome (FASI) on 22 February 2022 at 2 153.6 engine hours; the helicopter had accumulated 330 hours since overhaul at the time of the accident.

2.2.2.5 The engine was recovered to the SACAA-approved engine facility at Springs Aerodrome (FASI) and was subjected to a teardown inspection. The AMO found that the idler gear shaft flange bolt hole had fractured.

2.2.2.6 The failed idler gear and fasteners (bolts and nuts) were sent to the engine manufacturer (Lycoming). The technical report post-inspection indicated that the idler gear shaft flange bolt hole had fractured. The failed flange bolt was subjected to a microscopic analysis and the root cause of its failure was determined to be fatigue; the origin of the fatigue was unknown.

2.2.3. Environment

2.2.3.1 Favourable clear weather conditions prevailed at the time of the flight; therefore, the weather did not contribute to this accident.

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 Commercial Pilot Licence (CPL) on 13 August 2004. He renewed his CPL on 26 January 2023 with an expiry date of 31 February 2024. The pilot had flown a total of 9 848.2 hours of which 6 315 hours were on the helicopter type. The helicopter type was endorsed on the pilot's licence and logbook.

3.2.2. The pilot was issued a Class 1 aviation medical certificate on 25 August 2023 with an expiry date of 31 August 2024 with a medical waiver (correction for defective distant vision). The pilot was properly licensed and medically fit to conduct the flight in accordance with Part 67 of the CAR 2011 as amended.

3.2.3. The last MPI of the helicopter was conducted and certified on 30 May 2023 at 2 135.3 airframe hours. The helicopter had a total of 2 151.5 hours since new. It had accrued 16.2 hours since the last MPI.

3.2.4. The helicopter had a valid Certificate of Airworthiness (C of A) that was initially issued on 8 March 2017. The C of A was renewed on 16 March 2023 with an expiry date of 31 March 2024.

3.2.5. The Certificate of Release to Service (CRS) was issued on 30 May 2023 with an expiry date of 24 May 2024 or at 2 235.3 hours, whichever comes first.

3.2.6. The Certificate of Registration (C of R) was issued to the present owner on 7 February 2017. There were no defects reported prior to the accident flight; therefore, the helicopter was considered airworthy at the time of the flight.

3.2.7. The engine underwent an engine overhaul at the engine facility at FASI on 22 February 2022 at 2 153.6 engine hours. At the time of the accident, the engine had accumulated 330 hours since the overhaul.

3.2.8. The AMO that maintained the helicopter had a valid AMO Certificate that was issued by the SACAA on 3 November 2022 with an expiry date of 30 November 2023.

3.2.9. The engine teardown inspection indicated that the crankshaft idler gear fractured from the stud side during flight. The failed flange bolt was subjected to a microscopic analysis and the root cause of its failure was determined to be fatigue; the origin of the fatigue was unknown.

3.3. Probable Cause/s

3.3.1 The engine lost power during the final approach to land at Marataba Mountain Lodge in Limpopo province; consequently, the helicopter entered an uncontrolled descent which resulted in a hard landing with the landing gear skids.

3.4. Contributory Factor/s

3.4.1 The flange bolt that secured the idler gear failed due to fatigue; the origin of the fatigue was unknown.

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. Appendix A,B,C: Extract from Lycoming materials laboratory investigation report.

This report is issued by:

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

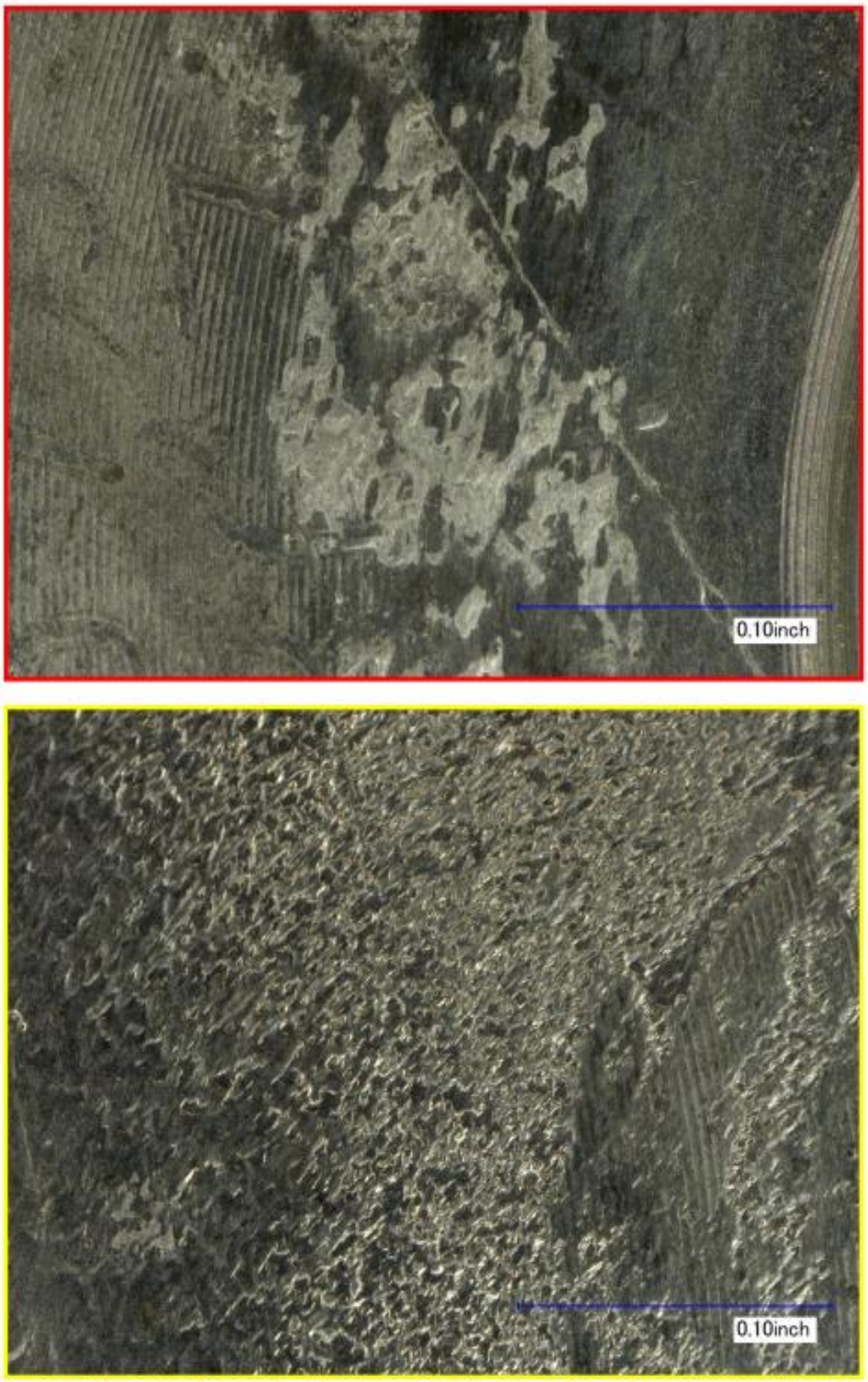


Figure 4. The flange contains contact wear marks. The line in the red box image is likely a scratch.

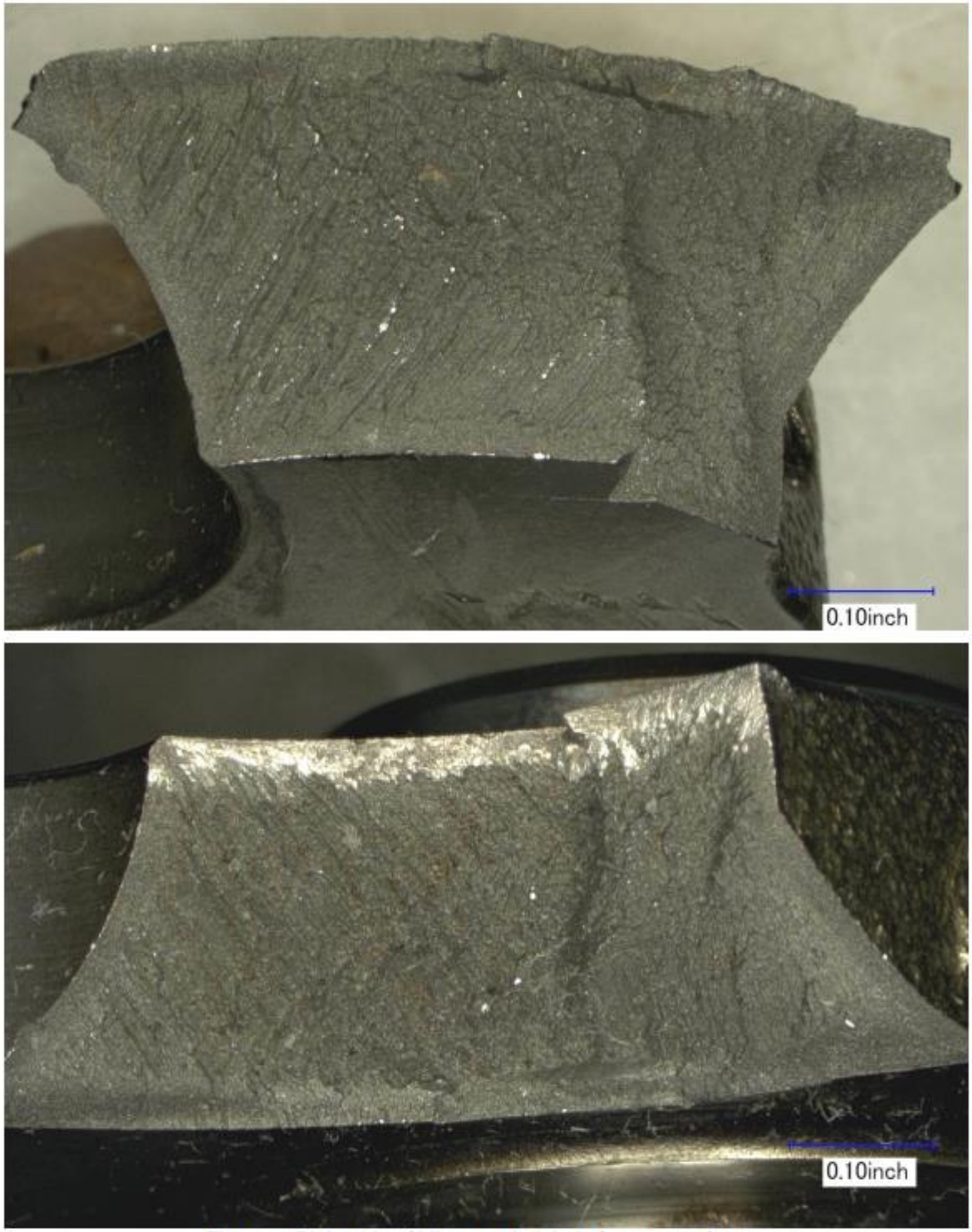


Figure 5. Right side of idler gear bolt hole fracture surfaces.

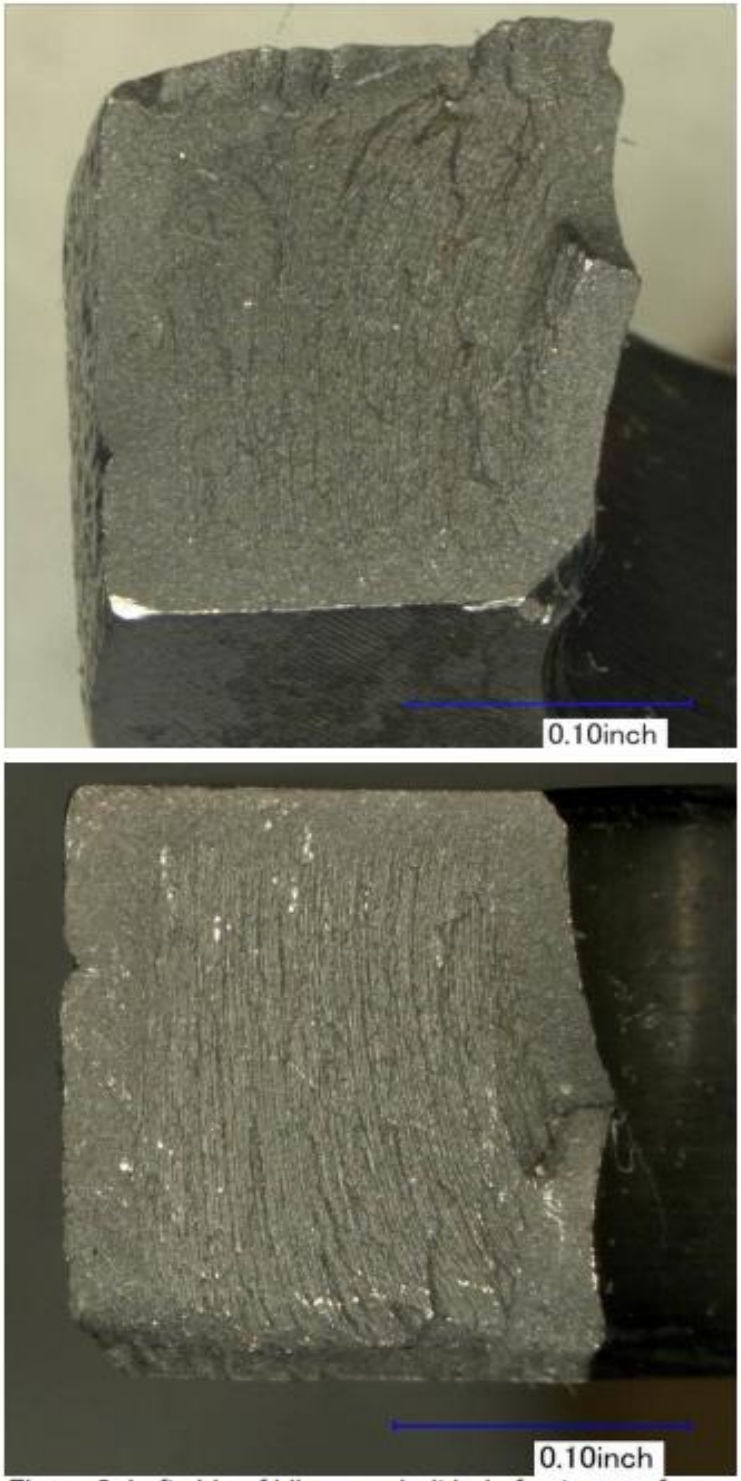


Figure 6. Left side of idler gear bolt hole fracture surfaces.

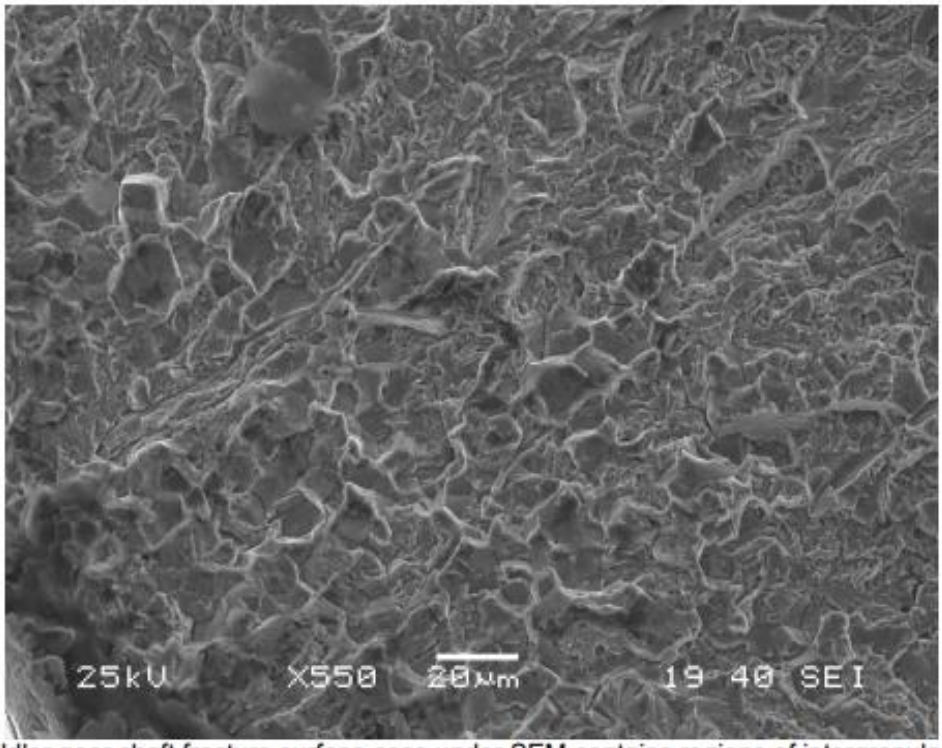


Figure 7. Idler gear shaft fracture surface case under SEM contains regions of intergranular fracture.

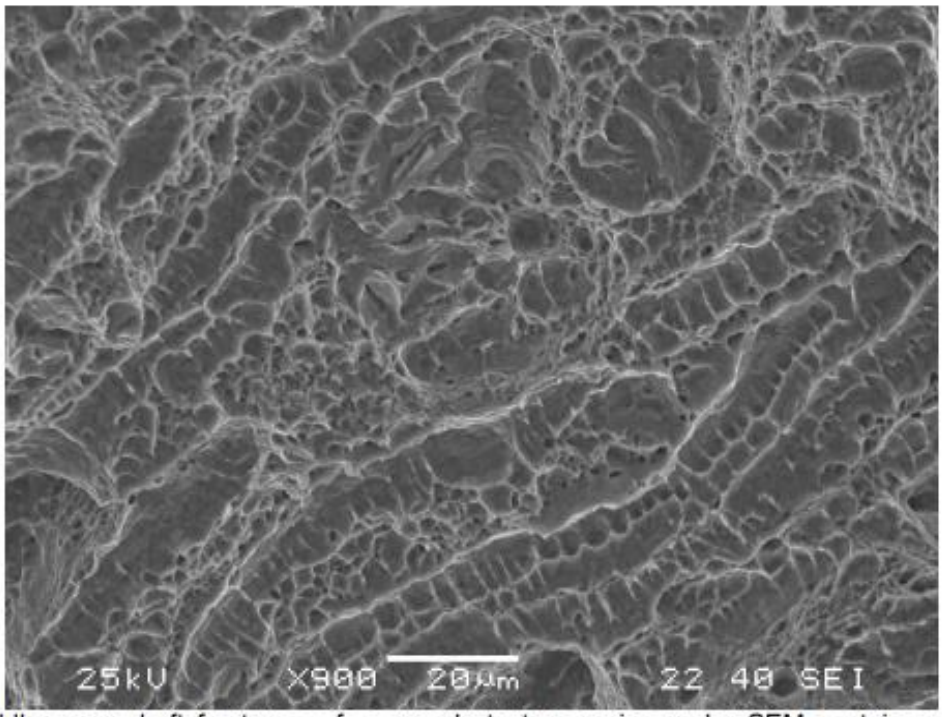
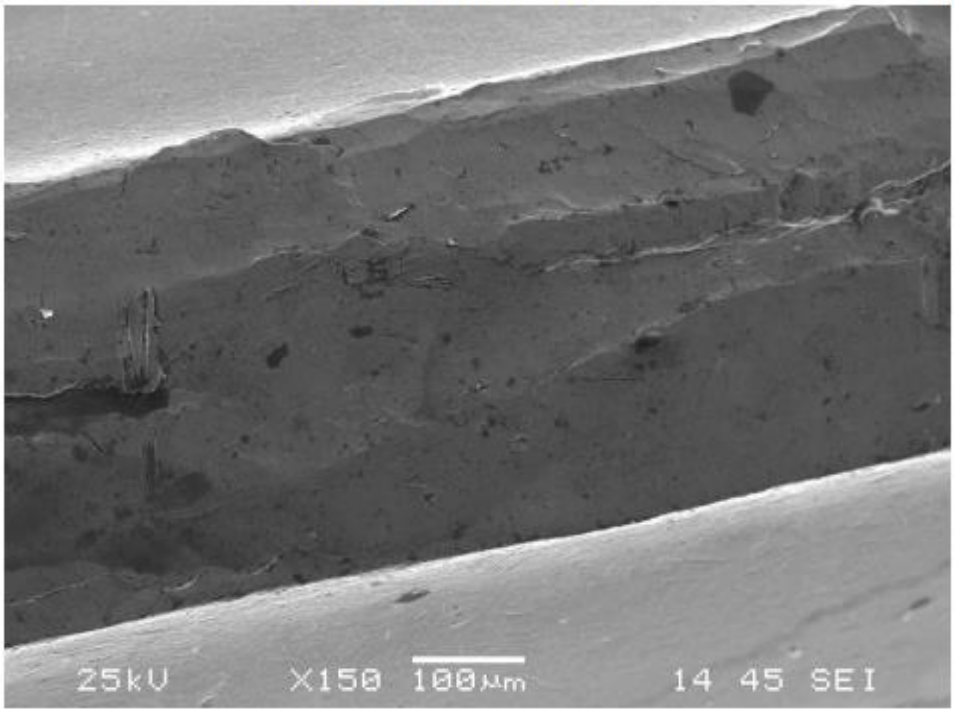


Figure 8. Idler gear shaft fracture surface woody texture region under SEM contains evidence of ductile overload.

5.2. Appendix B: Extracted from Lycoming materials laboratory investigation report.



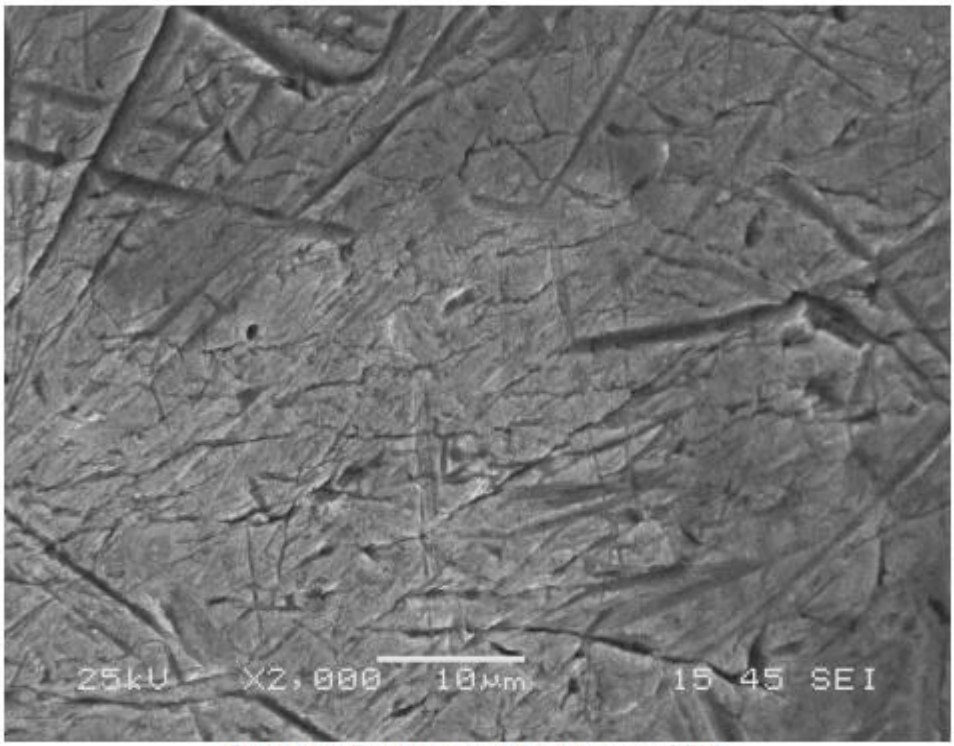


Figure 20. Fractured bolt thread under SEM.

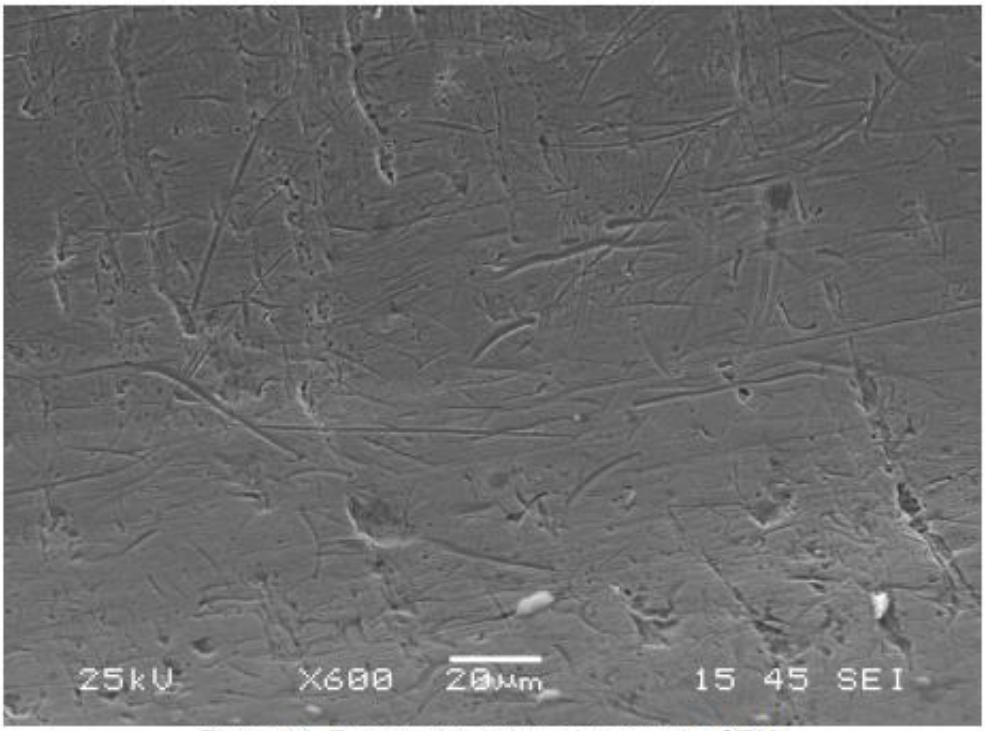


Figure 21. Fractured bolt thread root under SEM.

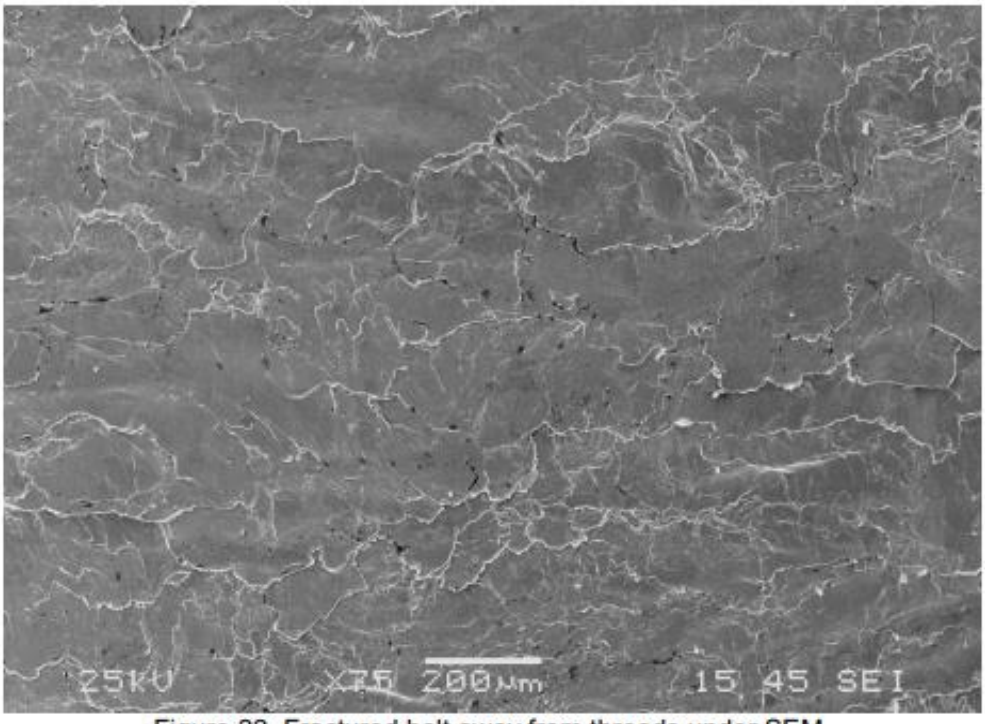
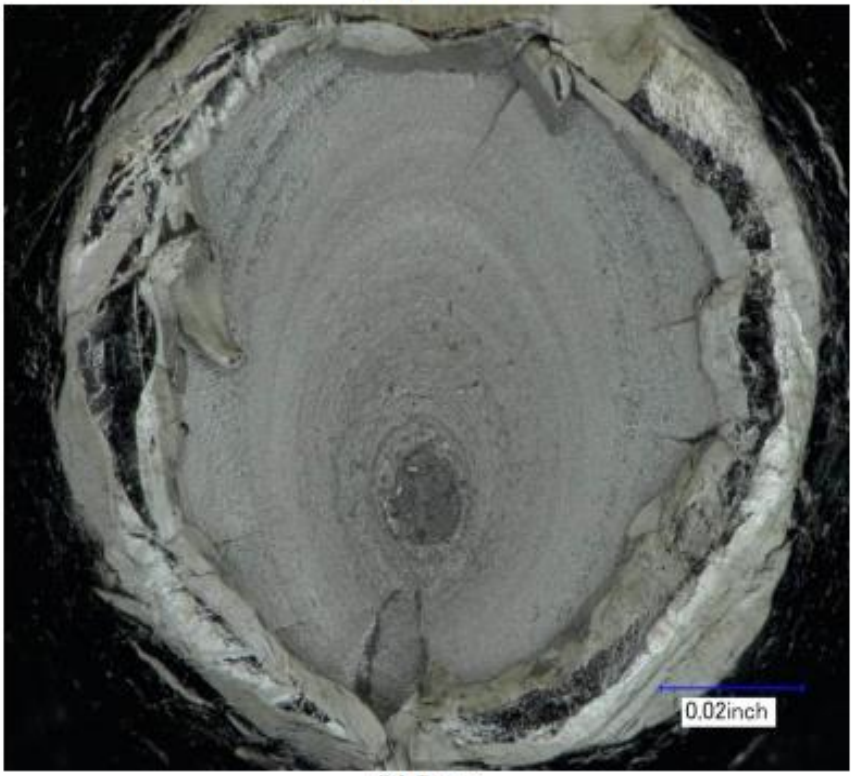


Figure 22. Fractured bolt away from threads under SEM.

(a) Head



(b) Base

Figure 23. Bolt fracture surfaces. Ratchet marks and beach marks are evidence of fatigue.

5.3. Appendix C: Extracted from Lycoming materials laboratory investigation report.

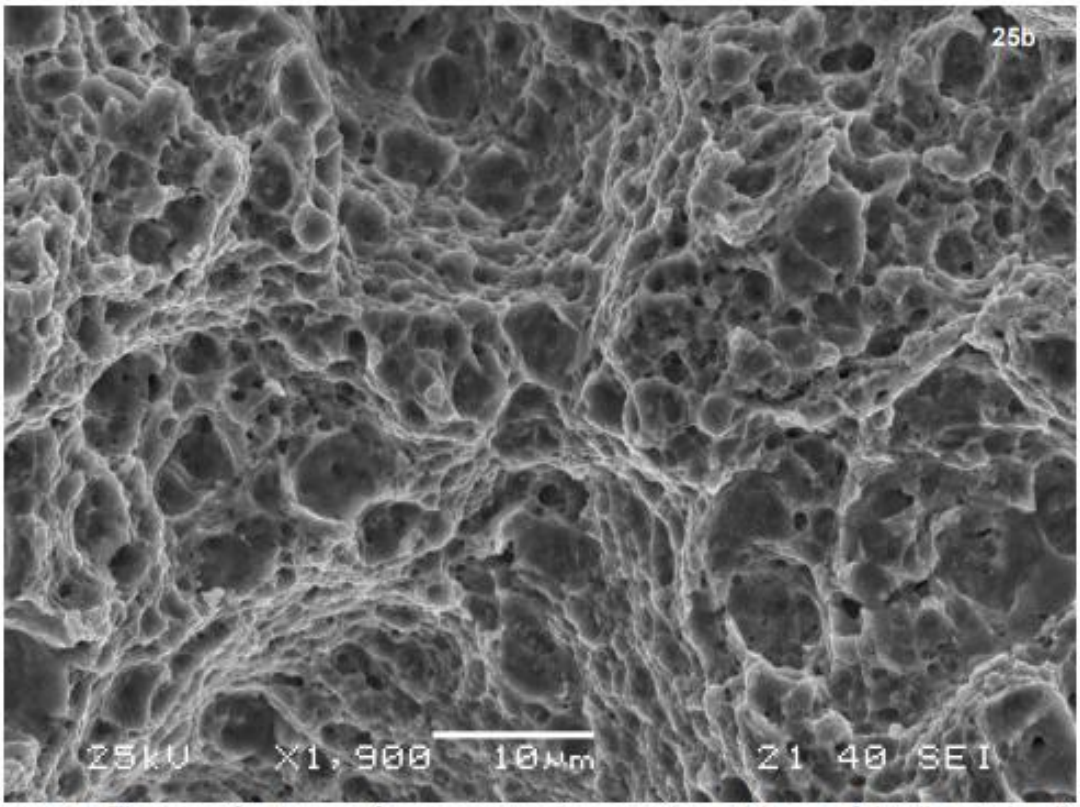


Figure 25. The base fracture surface center region contains evidence of ductile overloading.

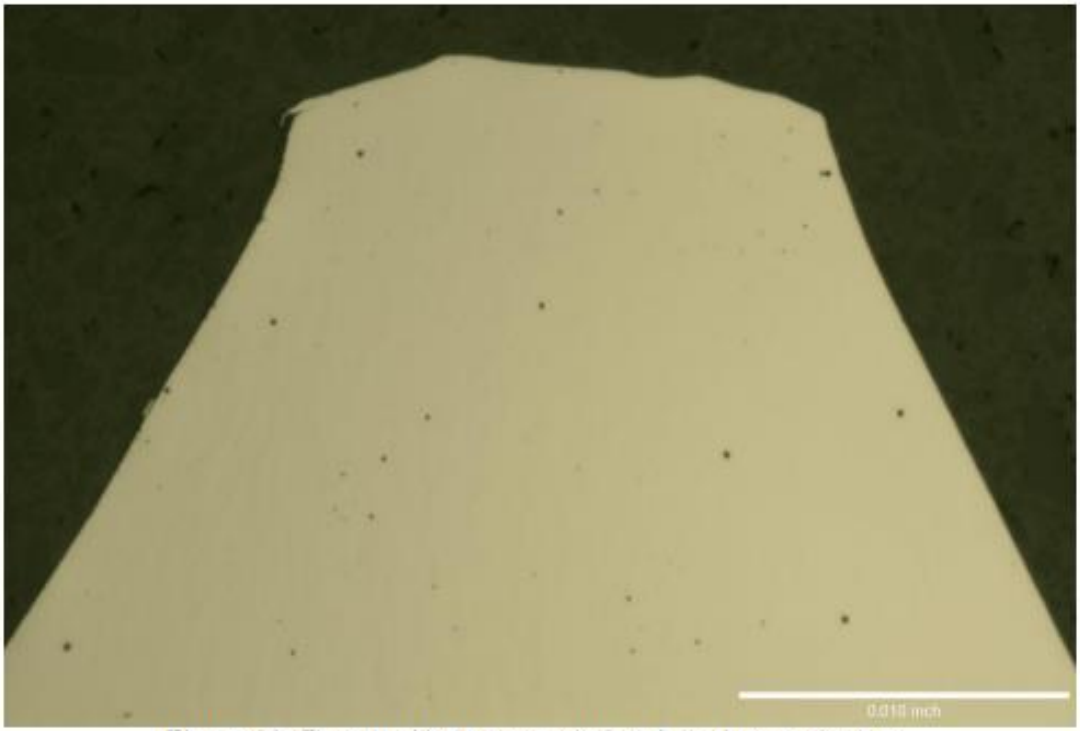


Figure 26. Fractured bolt cross-section thread tops are worn.

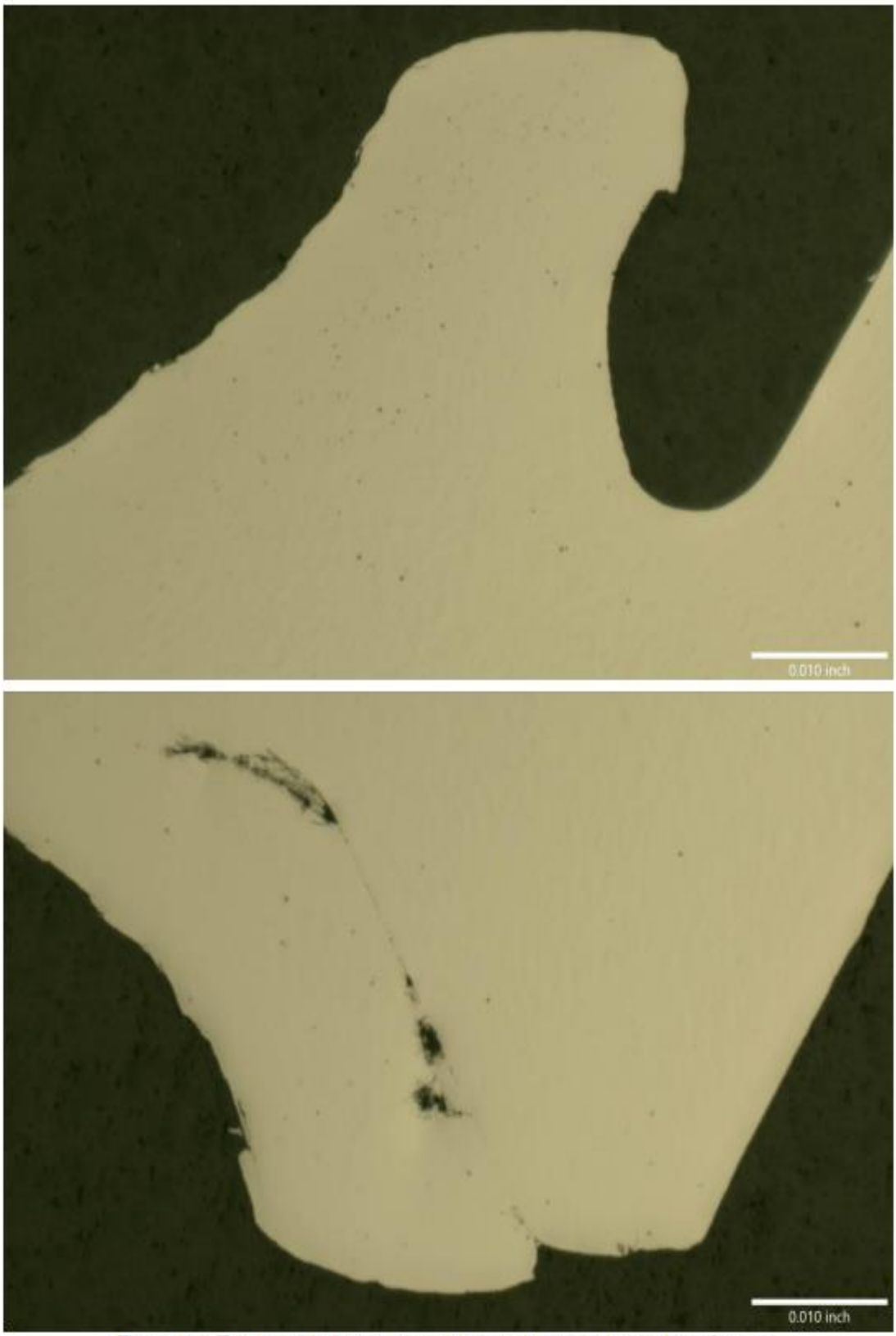
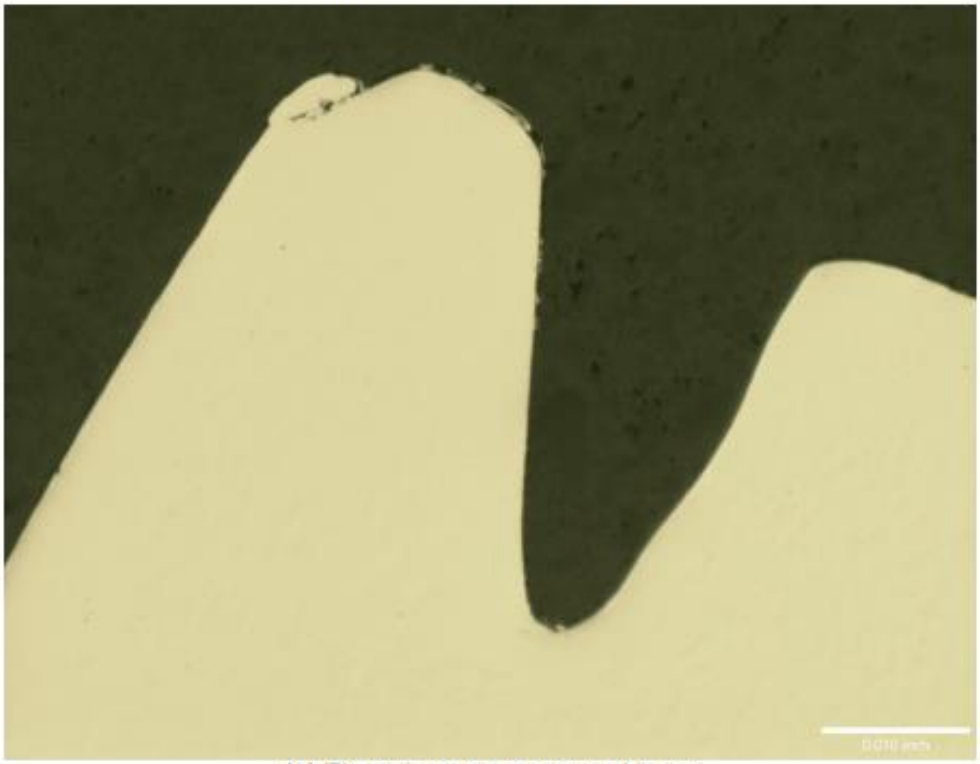
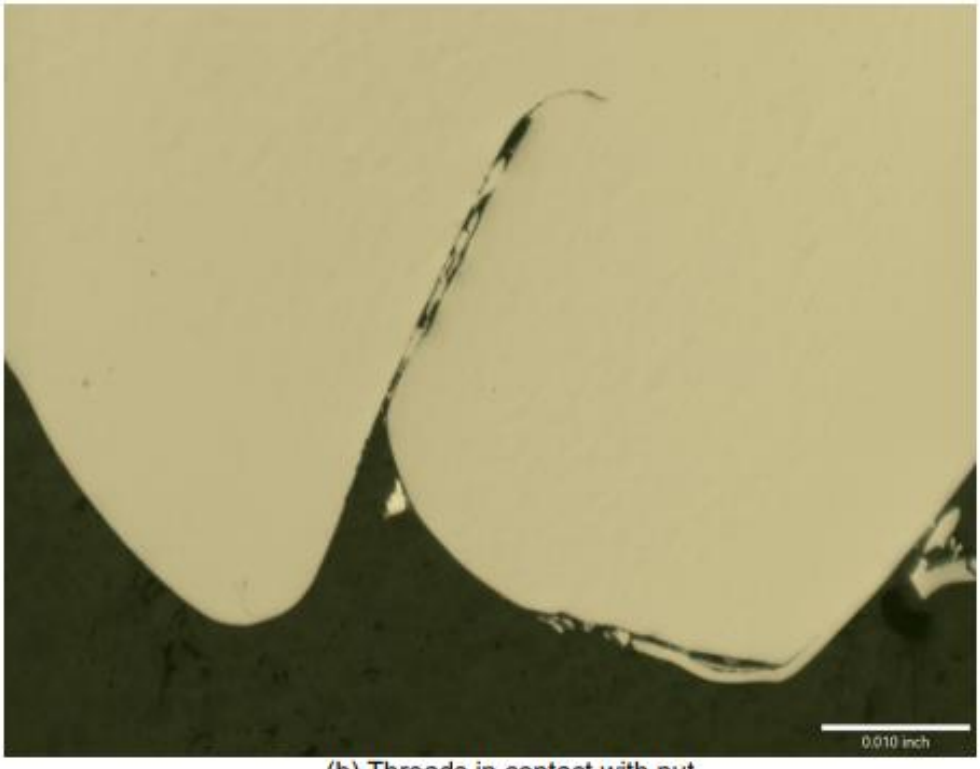


Figure 27. Fractured bolt cross-section last thread is severely deformed.



(a) Threads not in contact with nut



(b) Threads in contact with nut

Figure 34. The non-fractured stud cross-section threads are severely deformed.