

National Transportation Safety Board

Office of Aviation Safety

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CEN22LA138

INVESTIGATION SUMMARY

February 22, 2024

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A. ACCIDENT

Location: Gulfport, Mississippi
Date: March 6, 2022
Time: 2130 central standard time
Airplane: N8170J, Beech 200

B. SUMMARY

On March 6, 2022, about 2130 central standard time, a Beech 200 airplane, N8170J, was substantially damaged when it was involved in an accident at Gulfport-Biloxi International Airport (GPT), Gulfport, Mississippi. The pilot and four passengers were not injured. The flight was operated as a Title 14 *Code of Federal Regulations* Part 91 business flight.

According to the Federal Aviation Administration (FAA) inspectors, the airplane was on approach to Stennis International Airport (HAS), Bay St Louis, Mississippi, when the pilot attempted to extend the landing gear. During the gear extension process, the passengers heard a "loud bang" under the floor panels, and the pilot reported that the gear would not extend. The pilot diverted to GPT and attempted to extend the landing gear manually, which was unsuccessful as the system was "jammed." The pilot landed with the gear retracted and the airplane sustained substantial damage to the fuselage and empennage. After landing, there was a small fire under the right engine nacelle.

On March 15, 2022, the FAA responded to GPT and examined the airplane on the ramp and determined there was substantial damage to the rear of the fuselage. They pulled the floor panels and did not find anything out of the ordinary. Since the airplane was still resting on the ramp with the landing gear retracted, they could not examine the landing gear system.

On June 28, 2022, the FAA completed a landing gear examination with the recovery company. When they lifted the airplane with a crane, the gear was still jammed and could not be actuated with the gear handle or manual extension. They cut the landing gear drive shafts to the left and right actuators. The left drive shaft was successfully rotated with channel lock pliers. The right shaft would barely move and exhibited a binding sound/feel. The airplane was relocated to the recovery facility where the right main landing gear actuator was removed and shipped to the FAA ACO in Wichita, KS.

On January 10, 2023, the right main landing gear actuator examination and disassembly was completed at the Textron Aviation facility with FAA ACO oversight.

C. DETAILS OF THE EXAMINATION

1.0 Right Main Landing Gear Actuator

The following is a summary of Textron Aviation Inc., Material and Process Engineering Report No. 23-359-005.

P/N:	99-810057-653	Model:	200 Super King Air
Part Description:	Main Landing Gear - Manual Actuator	A/C S/N:	BB-728
Part Serial Number:	050425030	Tail Number:	N8170J
		Hours in Service:	-

EXAMINATION

Before examination, the Hawker Beechcraft Corporation Manufactured Component Maintenance Manual - Landing Gear Actuators P/N 99-810057 and 115-810021 was reviewed. A diagram was taken from the maintenance manual and merged with a table that defines each component in Figure 1. The terminology referenced in this report follows the nomenclature identified in Figure 1.

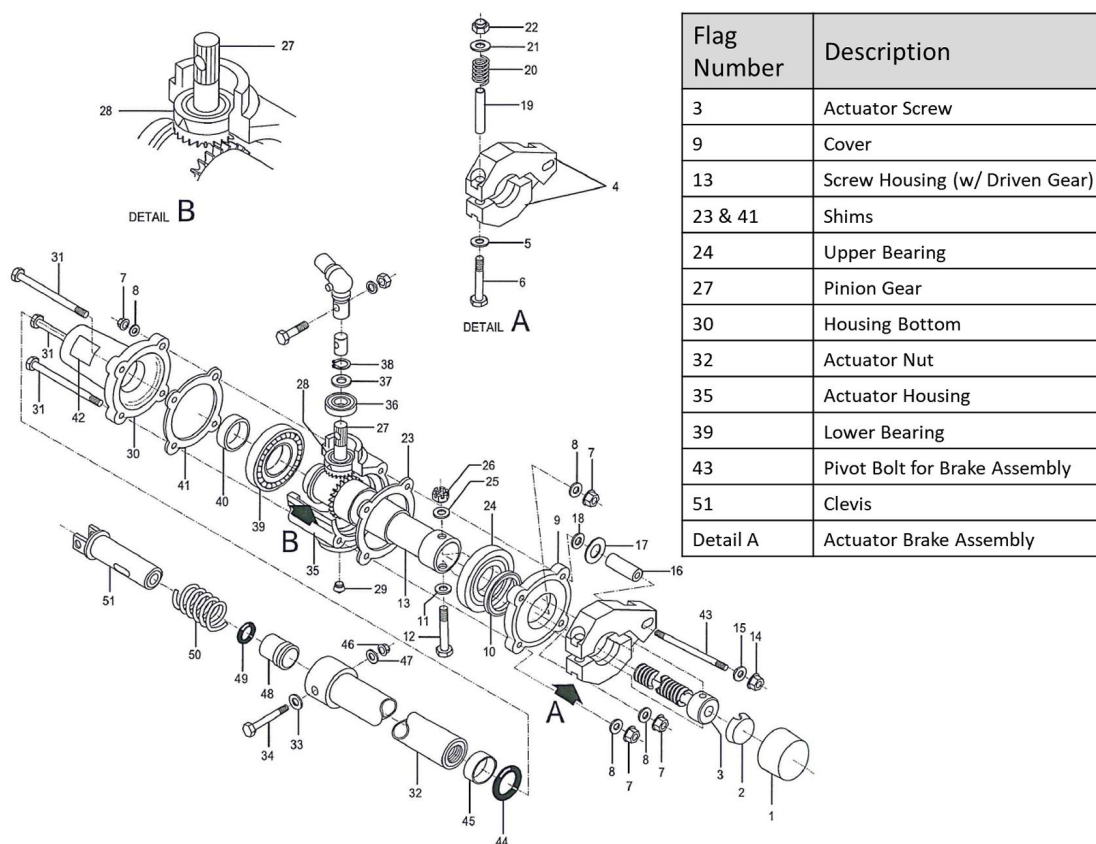


Figure 1. Exploded view taken from maintenance manual, page 32-31-01.

Received Condition

The actuator assembly exterior was documented along with any visible damage, reference Figure 2. Before beginning the teardown of the assembly, a functional test was performed. The pinion gear shaft could only be turned about a quarter of a rotation and did not extend or retract the gear assembly. However, the actuator nut was able to rotate freely, indicating that the thread interface between the actuator nut and actuator screw remained functional.

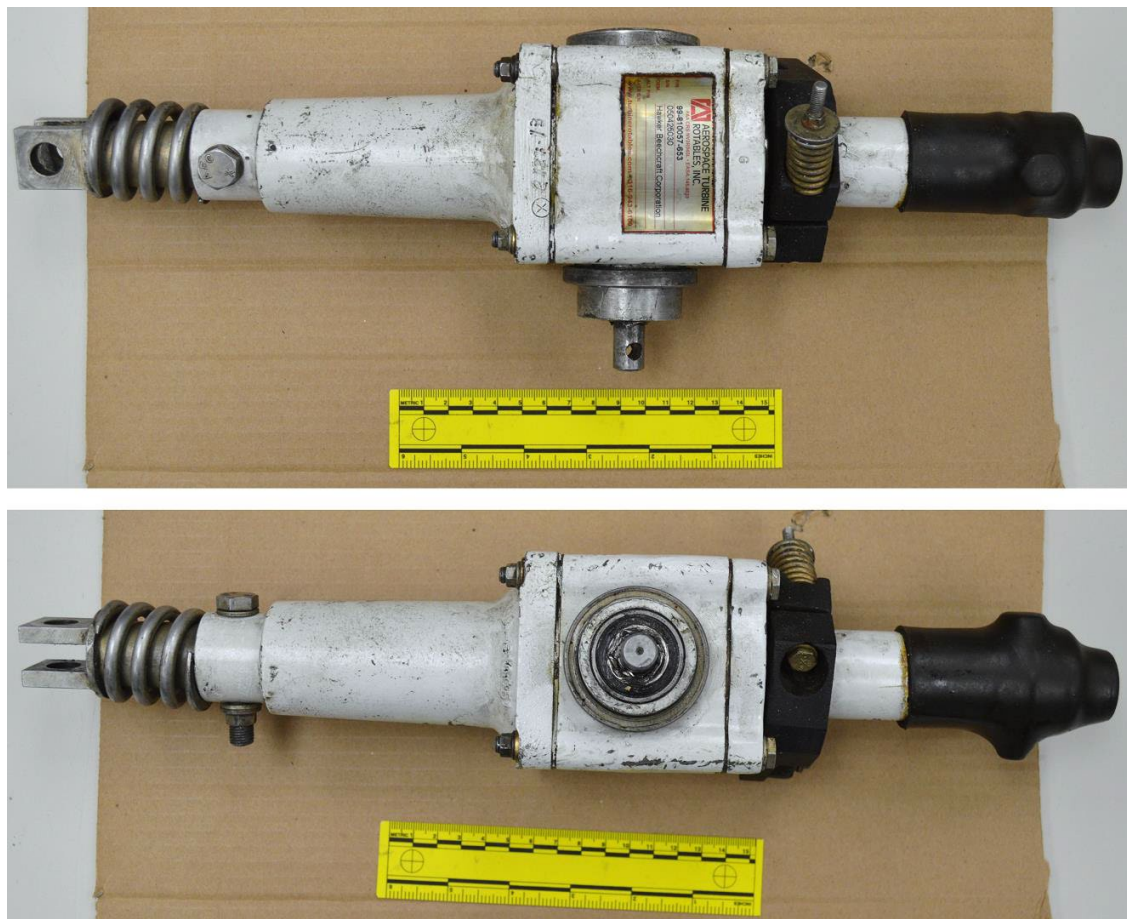


Figure 2. Overview images of exterior of gear actuator assembly as received.

Teardown

The removal steps provided in the maintenance manual were followed, starting with the removal of the Actuator Brake Assembly. There was one fastener that did not directly match the maintenance manual but did not appear to impact the function of the actuator brake assembly. Next, the boot was removed from the upper end of the screw housing. The clevis and spring were then removed from the Actuator Nut and followed by unscrewing the actuator nut from the assembly. The remaining housing bolts were removed, allowing the housing bottom and upper cover to be removed.

Analysis of Damaged Surfaces and Debris Collection

[illegible]

INVESTIGATION SUMMARY

Pinion/Drive Gear (115-810028-3)

Once the grease was removed from both gears, the part markings became visible. Both gears have similar scribed markings paired with their part number, 28606-31, indicating they are a matched set. As shown in Figure 4, the pinion gear had 8 broken teeth, with the majority of the failures being localized to the root/fillet area of the teeth.



Figure 4. 115-810028-3 Pinion/Drive Gear and Broken Gear Teeth.

Figure 5 helps illustrate the wear and breakage visible on the pinion gear. There were cracks present near the dedendum of the teeth still attached. The pinion gear had evidence of pitting along the pitch line of the teeth. Plastic flow was present along the addendum of the teeth. No discoloration was present on the surfaces of the teeth. A few of the broken teeth that had interior secondary fractures within the teeth. The different types of wear observed on the broken sections of the gear teeth are shown in Figure 6.

Types of Wear:

Plastic Flow

Cracking

Pitch Line Pitting

Flaking

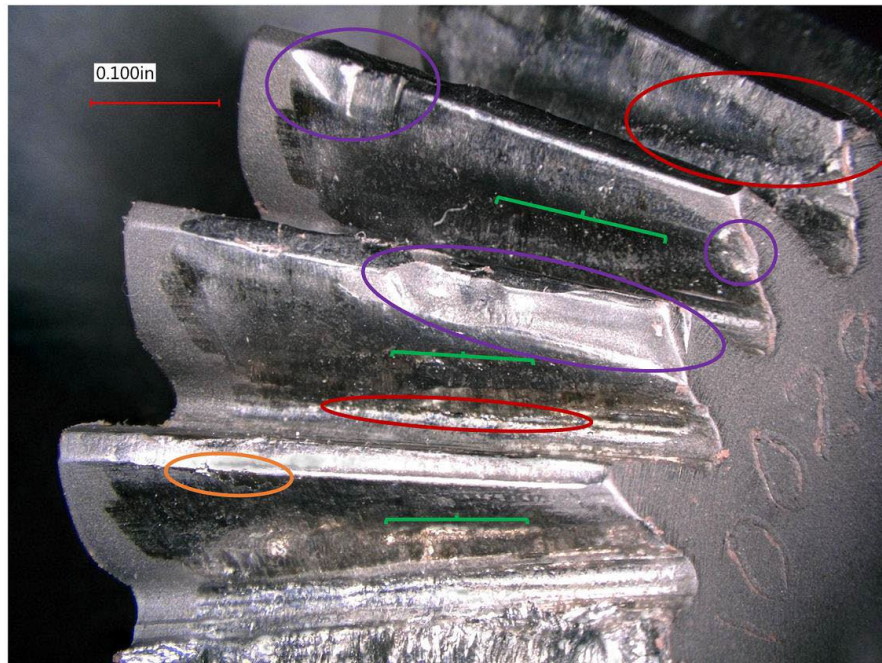


Figure 5. Different Types of Wear Visible on Teeth attached to Pinion/Drive Gear.



Figure 6. Different Types of Wear Visible on Pinion/Drive Gear Where Teeth are Missing.

After reviewing the damage, the gear was sectioned for further composition and microhardness analysis. To verify the case hardening of the gear, microhardness measurements were collected on an undamaged portion of several gear teeth. No wear was present near the wider end of the bevel gear teeth. A cross section was taken to obtain the microhardness measurements reported in the table below. The measured case hardness did not conform to the drawing requirements, but the case depth did meet the drawing requirements. After hardness testing, the cross-section was etched with 2% Nital to reveal the case within the microstructure.

Driven Gear (115-810025-1 Braze Assy - Gear 115-810027-1)

The damaged driven gear retained most of its teeth, as shown in Figure 7. A combination of partial tooth breakage/cracks and plastic flow were the primary wear patterns on the driven gear, reference Figure 8. No discoloration was present on the surfaces of the teeth. The plastic flow was localized to the addendum of the gear teeth, but cracks were found in regions near or below the pitch line of the teeth.



Figure 7. 115-810025-1 Driven Gear with damaged Gear Teeth.

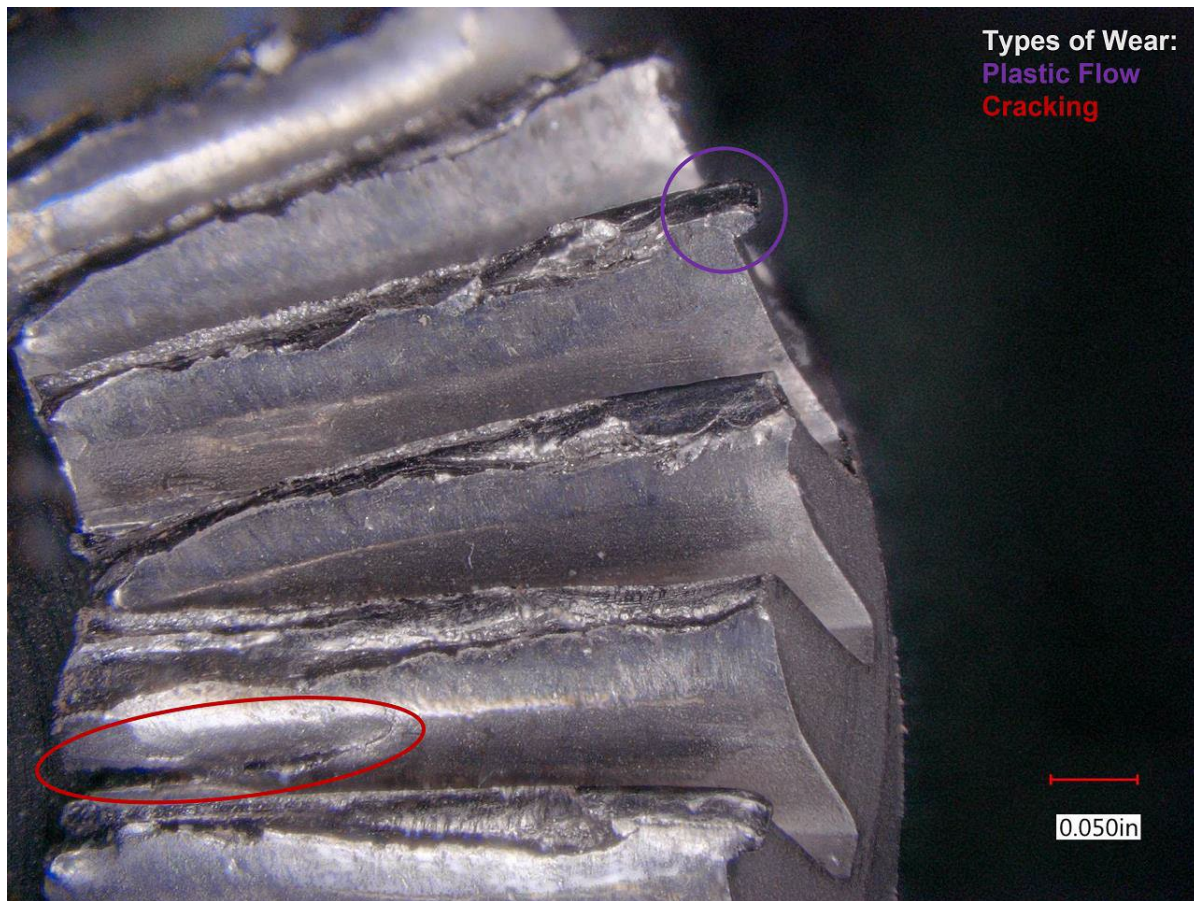


Figure 8. Different types of wear present on damaged teeth from the Driven Gear.

After reviewing the damage, the gear was sectioned for composition and microhardness analysis. To verify the case hardening of the gear, microhardness measurements were collected on an undamaged portion of a gear tooth. No wear was present near the base of the outside surface of the teeth. A cross section was taken to obtain the microhardness measurements. The measured case hardness and depth did not meet the drawing requirements. The hardness tests did not indicate the presence of a case layer. Etching with 2% Nital, after hardness testing, did not reveal a case layer.

Actuator Housing (115-810023-3)

The vertical scoring/grooves in the inner bore, as shown in Figure 9, were made during the removal of the damaged driven gear. The secondary damage within the case is likely a result of the gear mesh fracturing/deforming resulting in secondary damage.

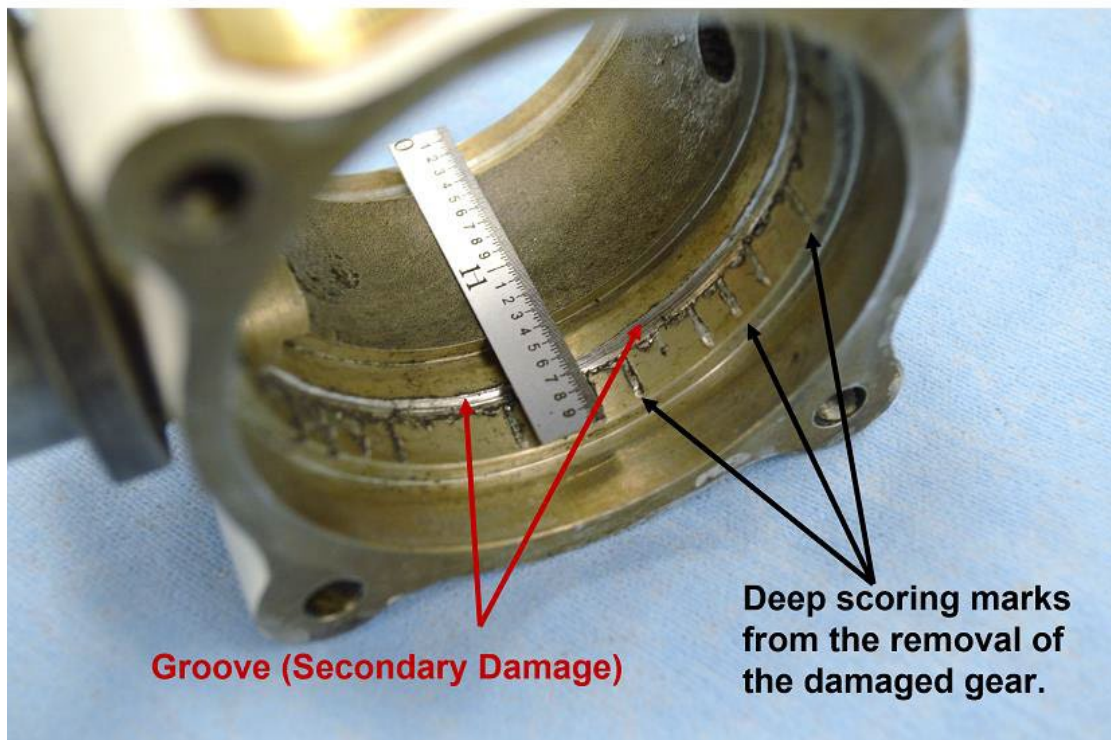
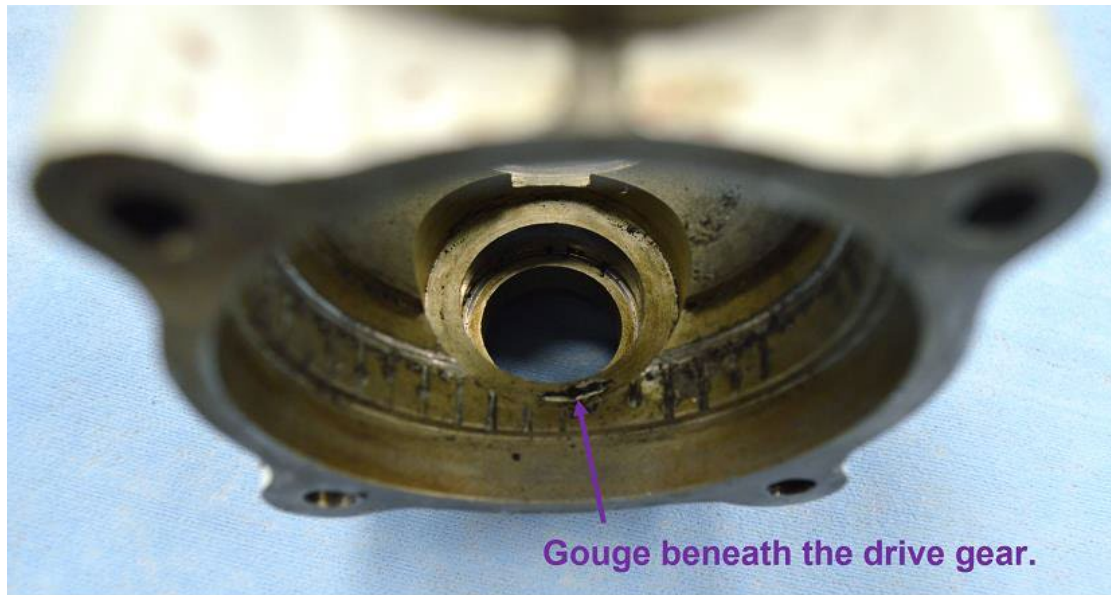


Figure 9. Visible damage inside the actuator housing.

Grease Analysis

During the teardown, a sample of the grease was collected from the interior of the actuator after removing the screw housing from the actuator housing. The grease was evaluated using FTIR, and it was identified as Aeroshell 64. Based on the peaks present within the Spectrum collected from the sample, the grease did not appear to be degraded.

Upper and Lower Bearings

The Lower bearing was removed in pieces due to its design utilizing a floating bearing cage. The components were cleaned of grease and visually inspected for damage. The Upper Bearing was pressed from the screw housing and then inspected. The bearing cage prevented any non-destructive teardown of the bearing. Visual inspection of the assembled bearing was done after cleaning, and no immediate indicators of wear or damage were present.

FINAL OBSERVATIONS / CONCLUSIONS

Completion of the examination produced the following conclusions:

1. The initial component failure originated between the straight bevel gear set.
2. Breakage of the teeth from the pinion varied in fracture surface and location. The individual teeth that broke off have different features in comparison to the 6 adjacent teeth that were broken.
 - a. The individual broken teeth show cracking features that would have developed progressively before failure.
 - b. The group of adjacent broken teeth have evidence of shear overload and tensile overload indicating the failure was abrupt and possibly related to shock overloading.
 - c. Due to smearing that occurred during the final stages of mechanical failure it obscures additional evidence to the failure modes present.
3. The broken teeth recovered from the pinion gear have internal secondary cracks.
4. The driven gear teeth were plastically deformed and cracked along the tip of the addendum as it smeared against the broken section of pinion teeth. Additional cracks were observed near the root of the driven gear but cannot be confirmed as either a result of fatigue or overload cracking.
5. The appropriate grease was used and abundant within the housing.
6. Both the pinion and driven gears were confirmed to be the correct alloy per the drawing requirements.
7. The pinion gear has effective case hardening to the appropriate depth but does not meet the drawing requirements for minimum case hardness.
8. The driven gear did not have evidence of case hardening and does not meet the drawing requirements for both effective case depth and minimum case hardness.

Submitted by:

Joshua Lindberg
Senior Aviation Accident Investigator