

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



ERA23LA293

AIRWORTHINESS

Specialist's Factual Report

July 23, 2024

A ACCIDENT

Location: Waldorf, Maryland
Date: July 9, 2023
Time: 1027 eastern daylight time
Helicopter: MD Helicopters 369D, registration N5027P

B AIRWORTHINESS INVESTIGATOR

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Washington, District of Columbia

C SUMMARY

On July 9, 2023, at 1027 eastern daylight time, a Hughes 369D helicopter, N5027P, was substantially damaged when it was involved in an accident near Waldorf, Maryland. The commercial pilot and two observer crewmembers sustained minor injuries. The helicopter was operated by Haverfield Aviation, Inc. as a Title 14 *Code of Federal Regulations* Part 91 powerline inspection flight.

The wreckage was recovered to Anglin Aircraft Recovery in Clayton, Delaware. On August 9, 2023, the National Transportation Safety Board (NTSB) investigator-in-charge and representatives from the Federal Aviation Administration (FAA), Rolls-Royce, and Haverfield Aviation examined the recovered wreckage at Anglin Aircraft Recovery facilities. The examination found the overrunning clutch outer race's splined shaft had fractured; the fracture surfaces exhibited signatures consistent with fatigue (**Figures 1 and 2**). The overrunning clutch assembly was retained for further examination by the NTSB Materials Laboratory in Washington, District of Columbia (DC). The scope of this report is focused primarily on the overrunning clutch assembly from the accident helicopter.

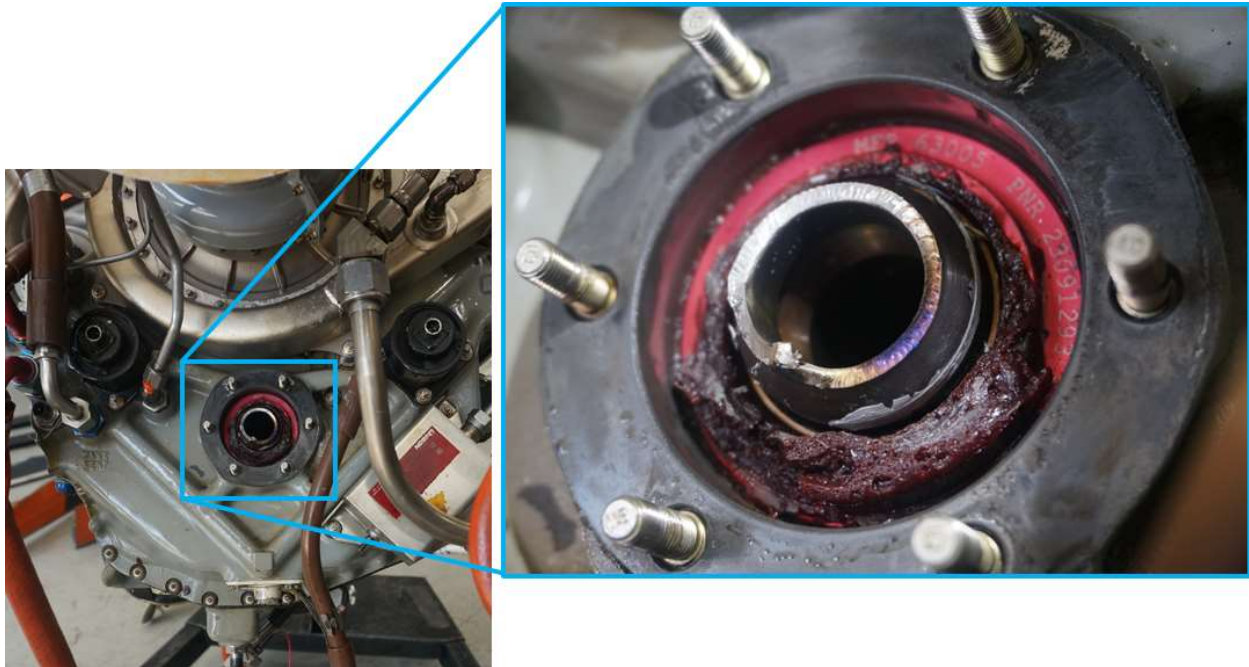


Figure 1. The fractured outer race splined shaft of the overrunning clutch, still installed in the engine gearbox.



Figure 2. The accident overrunning clutch subassembly.

D DETAILS OF THE INVESTIGATION

1.0 Helicopter Information¹

1.1 Helicopter Description

The MD Helicopters 369D has a five-bladed, fully-articulated main rotor system that provides helicopter lift and thrust. The 369D has a two-bladed teetering tail rotor system that provides lateral thrust to counteract main rotor torque and for directional control of the helicopter. The helicopter is equipped with one Rolls-Royce 250-C20B turboshaft engine. The helicopter is type certificated under FAA type certificate data sheet No. H3WE.

1.2 Helicopter History

The accident helicopter, serial number (S/N) 611002D, was manufactured in 1981. At the time of the accident, the helicopter had an aircraft total time (ATT) of 24,821.4 hours and a Hobbs time of 709.7 hours. According to the operator's maintenance records, the accident overrunning clutch subassembly was P/N 369A5350-51 and S/N 6968, which were confirmed during examination of the component.

2.0 Overrunning Clutch

2.1 Overrunning Clutch Overview

According to the MD Helicopters 369-series maintenance manual No. CSP-HMI-2, the overrunning clutch subassembly can be replaced in lieu of replacing its next higher level assembly, the overrunning clutch assembly. Major components of the clutch subassembly include the outer race, inner race, sprag assembly, forward and aft sprag bearings, and the output bearing (**Figure 3**). Adding the clutch housing and retaining ring to the clutch subassembly creates the next higher level assembly, the overrunning clutch assembly. According to the MD Helicopters 369-series illustrated parts catalogue No. CSP-IPC-4, for the MD 369D helicopter, the overrunning clutch assembly is P/N 369A5350-603 and the clutch subassembly is P/N 369A5350-41. Additionally, clutch subassembly P/N 369A5350-51, used on overrunning clutch assembly P/N 369A5350-605, is listed as a preferred part for the MD 369E, 369FF, and MD 500 helicopters.

¹ All left, right, up, and down orientations as well as clock positions referenced in this report are in the aft-looking-forward frame of reference unless otherwise specified.

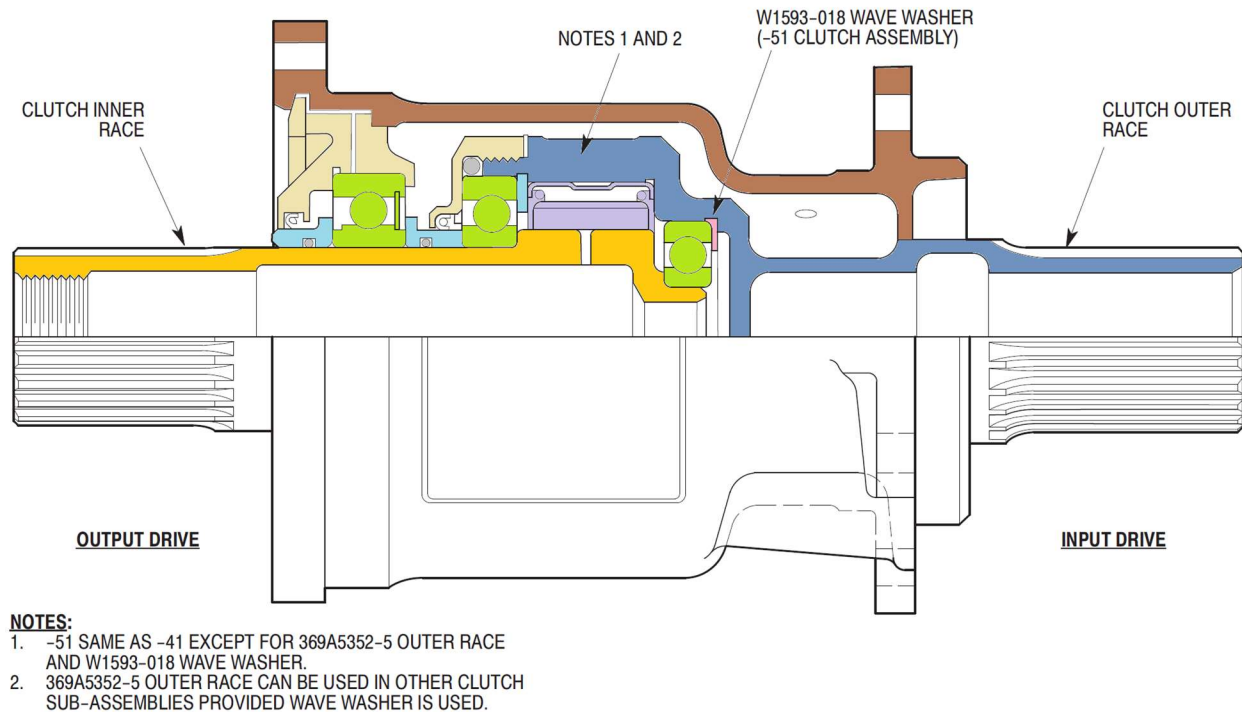


Figure 3. A cutaway view showing the internal components of the overrunning clutch assembly. The input drive (right side) is driven by the engine. The output drive (left side) provides drive to the engine-to-transmission (Kaflex) drive shaft. (Image courtesy of MD Helicopters)

According to the MD Helicopters Component Overhaul Manual No. CSP-COM-5, Section 63-10-10 (Overrunning Clutch), the P/N 369A5350-51 clutch subassembly is identical to the P/N 369A5350-41 clutch subassembly with the exception of the outer race and the wave washer. Specifically, on the -51 clutch subassembly, the outer race is P/N 369A5352-5, while on the -41 clutch subassembly, the outer race is P/N 369A5352. Furthermore, wave washer P/N W1593-018 is only used on the -51 clutch subassembly. Lastly, a caution states that the P/N 369A5363 bearing, marked SKF/MRC P/N R12, is prohibited from use in the -51 clutch subassembly. **Figure 4** shows an excerpt from MD Helicopters Component Overhaul Manual No. CSP-COM-5 on the conversion of a clutch subassembly to a P/N 369A5350-51 configuration.

Table 601. Overrunning Clutch Configuration Conversions

369A5350-() Configuration		Modification Required (Item No. Table 602)	
From	To		
-11	-51	1, 2, 3, 4, 5, 6	
-21	-51	1, 3, 4, 5, 6	
-31	-51	3, 4, 5, 6	
-41	-51	5, 6	

Table 602. Overrunning Clutch Modification Criteria

Item No.	Quantity	Parts to be Removed	Parts to be Installed	Nomenclature
1	1	369A5364	369D25351	Sprag Assembly
2	1	369A5368	369A5368-3	Seal, Oil (Note)
3	1	369A5365	369A5365-3	Nut Retainer
4	1	369A5353	369A5353-3	Race, Inner Clutch
5	1	369A5352	369A5352-5	Race, Outer Clutch
6	1		W1593-018	Washer, Wave



Do not use 369A5363 bearing, marked SKF/MRC, P/N R12, when converting to -51 configuration.

NOTE: Conversion of -11 configuration to -51 configuration overrunning clutch requires the 369A5368 oil seal on inner race be removed and replaced by 369A5368-3 oil seal (Ref. Figure 601).

Table 603. Overrunning Clutch Oil Capacity

Overrunning Clutch	Capacity
-11, -21, -31	1.52 U.S. Oz. (45 cc)
-41, -51	1.01 U.S. Oz. (30 cc)

Figure 4. The clutch subassembly configuration differences. (Image courtesy of MD Helicopters)

According to the MD Helicopters 369-series maintenance manual No. CSP-HMI-2, sprag assembly P/Ns 369A5364, 369D25351, and 369F5456 do not have a life limit when no cargo hook is attached. However, when a cargo hook is attached the sprag assembly has a life limit of 1,800 hours.² The sprag assembly has a mandatory inspection interval of 300 hours.³

² A note in the airworthiness limitations allows for a life limit of 1,800 hours of external load operating time when it is logged separately.

³ FAA Airworthiness Directive (AD) No. 90-19-02 contains several required actions for certain overrunning clutch assemblies, including a recurrent inspection of the inner race, outer race, and sprag assembly at intervals not to exceed 300 hours time in service or at an annual inspection, whichever occurs first.

2.2 NTSB Materials Laboratory Examination

The overrunning clutch assembly was examined by the NTSB Materials Laboratory in Washington, DC. Examination of the fracture surface showed signatures consistent with fatigue. Other notable findings included evidence of a gap between the forward-most bearing's inner race and the clutch inner race shoulder, off-axis sprag contact marks around the circumference of the outer race, and asymmetric contact marks on the wave washer. Additionally, secondary microcracks were observed on the shaft portion of the clutch outer race. For additional details of the clutch assembly examination, see NTSB Materials Laboratory Report No. 24-030 in the docket for this investigation.

2.3 Overrunning Clutch Installation History on N5027P

According to accident helicopter records, a 100-hour helicopter inspection was completed by the operator on June 7, 2023 at an ATT of 24,799.3 hours. The 100-hour helicopter inspection included an inspection of the overrunning clutch, specifically for oil leakage, correct operation of the clutch, and regreasing of the clutch splines. These overrunning clutch inspections were signed off without noted discrepancies. **Table 1** shows the details of the overrunning clutch assembly's subcomponent P/Ns and S/Ns that were recently replaced and installed on the accident helicopter, based on a combination of maintenance reports and work orders.

Table 1. A summary of the components replaced and installed in the accident overrunning clutch assembly from May 2023 to July 2023.

<i>Date</i>	<i>ATT (hours)</i>	<i>Clutch Housing</i>	<i>Clutch Subassembly</i>	<i>Sprag Assembly</i>
July 9, 2023	24,821.4	P/N 369A5351-5 S/N 1619	P/N 369A5350-51 S/N 6968	P/N 369D25351 S/N 9870
June 9, 2023	24,799.3	P/N 369A5351-5 S/N 1619	P/N 369A5351-5 S/N 6968	P/N 369D25351 S/N 9870
June 7, 2023	24,799.3	P/N 369A5351-5 S/N 1619	P/N 369A5351-5 S/N 56454761	P/N 369D25351 S/N 10037
May 17, 2023	24,743.0	P/N 369A5351-5 S/N 1619	P/N 369A5351-5 S/N 56454761	P/N 369D25351 S/N 10037

2.4 Accident Clutch Subassembly History (S/N 6968)

Clutch subassembly S/N 6968 was installed on the accident helicopter on June 9, 2023. Based on the installation records, the clutch subassembly's sprag assembly had a time since new (TSN) of 1,199.4 hours. According to the operator, the hours accumulated on the clutch subassembly itself was not tracked, but rather its life

limited subcomponent, the sprag assembly, was tracked. There was no TSN or time since overhaul (TSO) of clutch subassembly S/N 6968 listed in maintenance records. **Attachment 1** contains the installation record of clutch subassembly S/N 6968 onto N5027P on June 9, 2023.

Prior to installation on N5027P, clutch subassembly S/N 6968 was installed on N175JL but was removed on February 8, 2023 to facilitate inspection per AD No. 90-19-02. A maintenance work card dated April 18, 2023 showed clutch subassembly S/N 6968 and sprag assembly S/N 9870 were inspected per AD No. 90-19-02, and a lubrication of its upper bearings was accomplished. This work card noted both a TSN and a TSO of 714.4 hours which, according to the operator, reflected times for clutch subassembly S/N 6968. The hours accumulated on sprag assembly S/N 9870 were not listed in this record. **Attachment 2** contains the last accomplishment of AD No. 90-19-02 on clutch subassembly S/N 6968 from April 2023.

The last known overhaul of clutch subassembly S/N 6968 was documented on an unsigned maintenance record dated June 19, 2021⁴. This record contained a list of installed subcomponents and listed an outer race S/N of 5034-0945, but did not list a S/N for the sprag assembly. The flight hours field within the record showed 2,891.7 hours which, according to the operator, was the TSN for clutch subassembly S/N 6968. **Attachment 3** contains the overhaul record for clutch subassembly S/N 6968 from June 2021.

Prior to the June 2021 overhaul, an overhaul of clutch subassembly S/N 6968 was accomplished on March 7, 2017. The March 2017 overhaul record showed outer race S/N 5304-0928 and sprag S/N 9345 were installed. The signed March 2017 overhaul record did not show a TSN, TSO, or flight hours. However, another overhaul record also dated March 7, 2017, but unsigned, showed a TSN of 1,109.0 flight hours which, according to the operator, was the TSN for clutch subassembly S/N 6968. **Attachment 4** contains the two overhaul records for clutch subassembly S/N 6968 from March 2017.

According to manufacturing records, the accident outer race, S/N 5304-0945, was manufactured in 2017. Based on the available records, the time-in-service for the accident outer race, S/N 5304-0945, and its installation date as part of the accident clutch subassembly, S/N 6968, could not be determined. Based on the available records, the date of installation of the accident sprag assembly, S/N 9870, into the accident clutch subassembly, S/N 6968, also could not be determined. Additionally, according to the operator, a sprag assembly may not have a TSN of zero hours, i.e. an unused sprag assembly, when it is installed on the clutch subassembly.

⁴ According to the operator, a signed version of the June 2021 overhaul record was provided on-site at the time of the accident. The author of this report could not locate this signed version of the overhaul record.

2.5 Past Overrunning Clutch Outer Race Fracture

On March 5, 2019, a MD Helicopters 369D, N89ZC, was substantially damaged when it impacted trees and terrain near Talking Rock, Georgia.⁵ The NTSB investigation of N89ZC found the overrunning clutch subassembly (S/N 3096G41) outer race's splined shaft had fractured in fatigue. The fracture appeared nearly identical to the fatigue fracture from clutch subassembly S/N 6968. Secondary microcracks were also found on the clutch outer race (S/N 5304-1012), which was of a different manufacturing heat treatment lot than clutch outer race S/N 5304-0945. The NTSB investigation of N89ZC found that pre-existing cracks on the engine mounts likely caused abnormal loading of the outer race, resulting in fatigue cracks to initiate on the clutch outer race shaft and failure of the outer race shaft about 34 hours after its installation onto N89ZC.

3.0 Engine Mounts

On May 21, 2024, the engine mounts from the accident helicopter were examined by the author of this report at Anglin Aircraft Recovery in Clayton, Delaware. Examination of the left, right, and center engine mount assemblies found they remained secured to the airframe with no evidence of looseness of the attachment hardware or of the hardware within each mount assembly. The engine mounts were removed from the airframe and subsequently examined by the NTSB Materials Laboratory in Washington, DC. The examination found no evidence of preimpact fractures.

E LIST OF ATTACHMENTS

Attachment 1 - Record of clutch subassembly S/N 6968 installation onto N5027P, dated June 9, 2023

Attachment 2 - Record of last inspection in accordance with AD No. 90-19-02 on clutch subassembly S/N 6968, dated April 18, 2023

Attachment 3 - Record of last overhaul of clutch subassembly S/N 6968, dated June 19, 2021

Attachment 4 - Record of overhaul of clutch subassembly S/N 6968, dated March 7, 2017

⁵ See NTSB No. ERA19FA118 for additional details of this investigation.

Submitted by:

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