



NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594

June 29, 2020

HELICOPTER SPECIALIST'S FACTUAL REPORT

NTSB No: ERA19FA118

A. ACCIDENT

Operator: Rotor Blade LLC
Aircraft: MD Helicopters 369D, Registration N89ZC
Location: Talking Rock, Georgia
Date: March 5, 2019
Time: 1110 eastern standard time

B. GROUP

No group was formed.

LIST OF ACRONYMS

AD	Airworthiness Directive
AMM	aircraft maintenance manual
CTSN	component time since new
CTSO	component time since overhaul
DC	District of Columbia
FAA	Federal Aviation Administration
FOD	foreign object debris
IIC	Investigator-In-Charge
JZP	Pickens County Airport
MDHI	MD Helicopters, Inc.
NTSB	National Transportation Safety Board
N1	gas producer turbine-to-compressor
N2	power turbine-to-pinion gear
P/N	part number
S/N	serial number

C. SUMMARY

On March 5, 2019, about 1110 eastern standard time, an MD Helicopters, Inc. (MDHI) 369D, N89ZC, was substantially damaged when it impacted trees and terrain near Talking Rock, Georgia. The commercial pilot was fatally injured. The helicopter was operated by Rotor Blade LLC as a Title 14 Code of Federal Regulations Part 133 external load flight. Visual meteorological conditions prevailed and no flight plan was filed for the local flight, which originated from a nearby field.

The pilot was using a 10-bladed aerial saw to trim trees along powerlines when the accident occurred. A witness reported that the helicopter performed the upper pass, then came around for the middle pass when it began to spin counterclockwise (nose-left direction). It completed one full rotation, and during the second rotation it struck trees before impacting the ground. The helicopter came to rest on its right side and the fuselage and tail boom were substantially damaged. Several witnesses noted that it was "windy" at the time of the accident.

At 1115, the recorded weather observation at Pickens County Airport (JZP), Jasper, Georgia, which was about 5 miles to the southeast of the accident location, included wind from 010° at 9 knots, visibility 10 miles, clear skies, temperature -1° C, dew point -10° C; and an altimeter setting of 30.18 inches of mercury.

The National Transportation Safety Board (NTSB) Investigator-In-Charge (IIC) responded to the accident, traveled to the accident site, and documented the wreckage. The overrunning clutch subassembly outer race was found to have fractured. The IIC shipped the overrunning clutch subassembly to the NTSB Materials Laboratory in Washington, District of Columbia (DC) for further examination.

On June 11-12, 2019, representatives from the NTSB, MD Helicopters, Rolls-Royce, and Rotor Blade LLC convened at Atlanta Air Salvage facilities in Griffin, Georgia, to examine the recovered wreckage. At the conclusion of the wreckage examination, the engine mounts were shipped to the NTSB Materials Laboratory and the engine-to-transmission drive shaft was retained by the NTSB for further examination.

In April 2020, the engine-to-transmission drive shaft was evaluated by the drive shaft manufacturer, Kaman, in Bloomfield, Connecticut.

C. DETAILS OF THE INVESTIGATION

1.0 HELICOPTER INFORMATION

1.1 HELICOPTER DESCRIPTION

The MD Helicopters 369D has a five-bladed, fully-articulated main rotor system that provides helicopter lift and thrust, and a two-bladed teetering tail rotor system that provides main rotor anti-torque and directional control. The helicopter is equipped with a skid-type high landing gear. The helicopter is equipped with one Rolls-Royce 250-C20B turboshaft engine. The helicopter is type certificated under Federal Aviation Administration (FAA) type certificate data sheet No. H3WE.

The terms “left”, “right”, “up”, and “down” are used when in the frame of reference of looking forward from the aft end of the helicopter, i.e. aft-looking-forward. All locations and directions will be viewed from aft-looking-forward unless otherwise specified. Additionally, clock positions are in the aft-looking-forward frame of reference unless otherwise specified. The main rotor rotates counterclockwise when viewed from above.

1.2 HELICOPTER HISTORY

The accident helicopter, serial number (S/N) 1089D, was manufactured in 1981. At the time of the accident, the Hobbs meter on the airframe showed 2,382.3 hours. According to maintenance records, the aircraft total time (ATT) was about 13,671.3 hours at the time of the accident. Engine S/N CAE-833590 was installed on the accident helicopter.

2.0 WRECKAGE EXAMINATION

2.1 ON SCENE WRECKAGE EXAMINATION

The helicopter impacted terrain at an elevation of 1250 feet mean sea level and came to rest on a heading of 037° magnetic and was laying on its right side (**Figure 1**). The right side of the main fuselage was crushed inward. The rear fairing on the right skid was damaged and separated due to impact, but the remaining landing gear components remained attached to the fuselage and exhibited minimal damage. The skid step was not installed on the helicopter at the time of the accident.



Figure 1. The helicopter at the accident site.

The engine remained attached to the airframe. The aft section of the tail boom was fractured about 4 feet aft of the tail boom attachment point to the main fuselage and was partially separated. The vertical stabilizer remained attached to the aft end of the tail boom, exhibited

minor impact deformation, and the upper fin was partially fractured. The horizontal stabilizer remained attached to the upper fin and exhibited substantial impact deformation. The aerial saw came to rest on the ground near the helicopter.

Flight control continuity was confirmed from the cockpit flight controls to the main rotor swashplate. The pedal control system remained installed and continuous up to the tail boom fracture, and remained attached to the tail rotor pitch control assembly. The collective control remained attached to the control tube and was found in the maximum “up” position. Continuity was confirmed from the collective-mounted twist grip throttle to the engine gas producer fuel control. The power turbine-to-pinion gear (N2) trim operated when electrical power, via the helicopter battery, was applied. The lateral and longitude trim operated when electrical power, via the helicopter battery, was applied. The fuel quantity sending unit was removed and fuel was observed within the fuel tank. The fuel shutoff was not activated, and the fuel shutoff valve remained open.

All five main rotor blades remained attached to the main rotor hub. The main rotor blades exhibited signatures consistent with low rotational energy at the time of ground impact. The main rotor head and main gearbox remained installed. Both tail rotor blades remained attached to the tail rotor hub. Chordwise scratching was observed on both tail rotor blades. Both tail rotor blades exhibited leading edge dents at its outboard end, and one of the two blades exhibited a partial fracture of the leading edge near the inboard end of the blade. The tail rotor hub and tail rotor gearbox remained installed. Oil was observed within the tail rotor gearbox.

The tail rotor drive shaft remained attached to the main gearbox flange coupling and was continuous up to the tail boom fracture. The aft end of the tail rotor drive shaft remained attached to the tail rotor gearbox input flange coupling.

The main rotor transmission fluid level indicated full via the sight glass. The engine-to-transmission driveshaft was rotated by hand and a corresponding movement was observed on the main rotor, confirming continuity of drive through to the main gearbox. No fractures were observed on the engine-to-transmission driveshaft. All drivetrain components to the tail rotor were present. The tail rotor drive shaft had a fracture co-located with the fractured tail boom, but no other anomalous damage was observed on the tail rotor drive train.

The overrunning clutch outer housing’s attachment flange to the engine gearbox was fractured at the flange (**Figure 2**). The shaft and spline end of the clutch outer race (on the engine side of the clutch) exhibited a circumferential fracture (**Figure 3**). Residual oil was found within the outer housing. Rotational scoring was observed on the interior of the outer housing near the upper bearing. Grease was observed within the upper bearing. The sprag clutch functioned normally when rotated. The snap ring was removed and exhibited tension. The overrunning clutch assembly was sent to the NTSB Materials Laboratory in Washington, DC for further examination. (See section 3.0 of this report for additional details on the overrunning clutch assembly.)

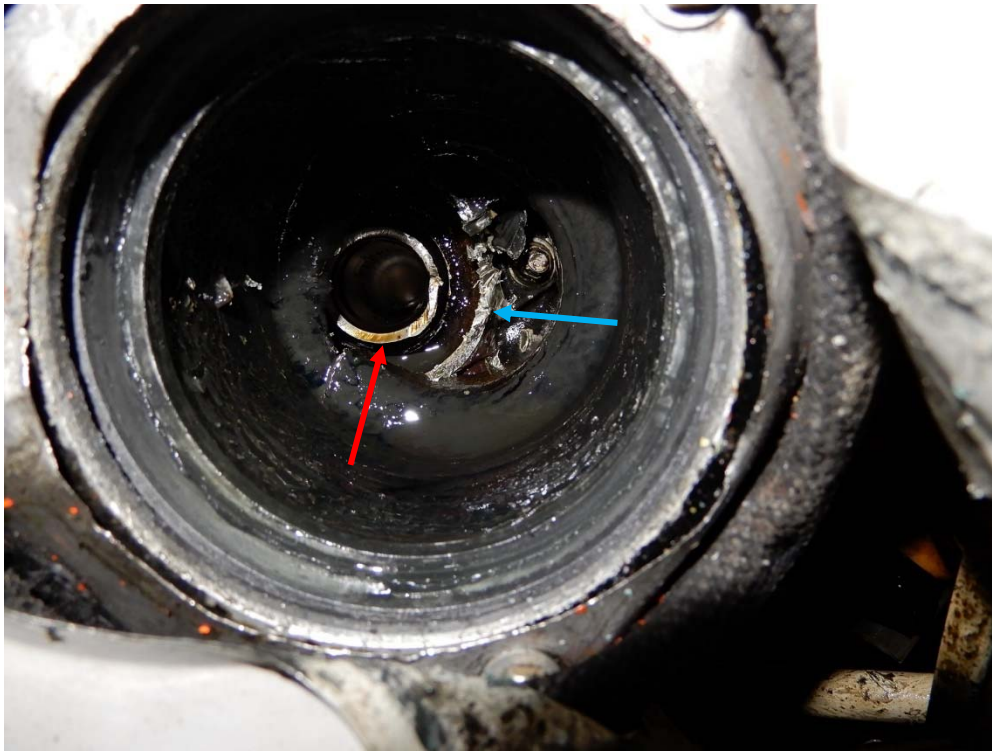


Figure 2. A view of the fractured outer race splines (red arrow) and the aft flange of the overrunning clutch outer housing (blue arrow), both still installed on the engine gearbox. This view is looking down the inner diameter of the remainder of the clutch outer housing.



Figure 3. The overrunning clutch subassembly after removal from the accident helicopter.

The engine-mounted fuel filter was removed, and residual fuel was observed in the filter bowl. No debris was found on the fuel filter and a minor quantity of debris was observed in the fuel filter bowl. No evidence of water was observed in the residual fuel.

An inspection panel was removed in the aft bulkhead of the cabin to access the engine. The compressor impeller assembly would not rotate when attempted by hand. The gas producer-to-compressor turbine (N1) drivetrain also would not rotate by hand. The drive gear connected to the overrunning clutch could be rotated by hand. The starter fan cover was removed, and the fan would not rotate by hand. The starter generator was removed from the engine and was able to be manually rotated by hand. The outer combustion case was removed and the first stage nozzle exhibited no evidence of thermal distress, cracks, missing material, or airfoil deterioration on the nozzle guide vanes.

2.2 POSTRECOVERY WRECKAGE EXAMINATION

On June 11-12, 2019, representatives from the NTSB, MD Helicopters, Rolls-Royce, and Rotor Blade LLC convened at Atlanta Air Salvage facilities in Griffin, Georgia, to examine the recovered wreckage.

2.2.1 ENGINE

The engine was removed from the airframe to facilitate its disassembly ([Figure 4](#)). The outer combustion case and compressor discharge tubes had been previously removed from the engine. The gearbox power output splines did not exhibit anomalous wear or fractures.

The upper and lower chip detectors were removed with no evidence of ferrous debris. The compressor module was removed from the engine and the compressor was manually rotated with no evidence of restriction. Removal of the compressor case revealed all six stages of the axial compressor, none of which exhibited evidence of damage due to foreign object debris (FOD) ingestion or other anomalous damage. The centrifugal compressor also did not exhibit anomalous damage aside from rubbing on the impeller blades. The impeller shroud exhibited corresponding contact rubbing along two localized arcs. Oil residue was present on both the interior and exterior of the compressor scroll.

The power turbine governor was removed and the governor drive shaft rotated freely with no evidence of excessive play. The fuel control was removed and the fuel control drive shaft rotated freely.

The power turbine module was removed and the N2 drivetrain rotated freely by hand. Residual fire retardant was observed on the power turbine blades. Carbon deposits were observed at the 10 o'clock position of the power turbine rotor. Continuity of the N1 drivetrain was confirmed by rotating the tachometer generator and observing rotation of the compressor. The compressor turbine wheels were removed and did not exhibit anomalous damage. Burnt oil was seen on 4 adjacent blades on the No. 2 compressor turbine wheel.

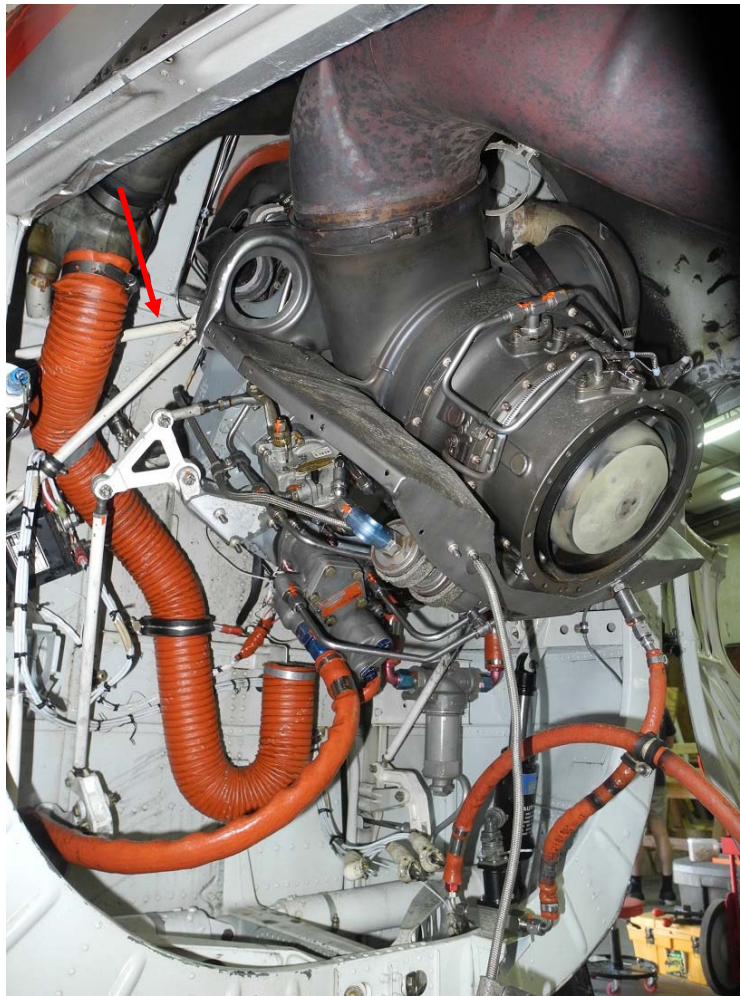


Figure 4. The engine as installed on the accident helicopter. The outer combustion case and compressor discharge tubes were previously removed. The red arrow points to the left engine mount.

The No. 1 gas producer turbine nozzle shield was removed and the first stage nozzle had black-colored material as well as non-ferrous metallic material adhered to the surfaces surrounding the No. 8 bearing chamber. The No. 1 bearing support was removed and the inlet guide vanes showed no evidence of anomalous damage except for one vane that exhibited impact damage. The Nos. 1 and 2 bearings showed no evidence of anomalous damage. The Nos. 6 and 7 bearing oil supply strut was removed and carbon deposits were observed. The screen for the Nos. 6 and 7 bearing oil filter was removed and no debris was observed. The No. 8 bearing sump cover was removed and the No. 8 bearing showed no evidence of anomalous damage. The No. 8 bearing oil supply strut exhibited no anomalous damage. The sump for the Nos. 6 and 7 bearings was removed and residual oil was observed in the sump.

The bleed valve was removed and showed no evidence of debris or blockage. The anti-ice valve was removed and disassembled. The anti-ice valve seat was not present and the screw was dislodged from the poppet. The fuel pump was removed and no anomalous damage was observed on the splined connection between the gearbox and the pump driveshaft. The fuel pump driveshaft rotated freely when turned by hand, and residual fuel was present within the fuel pump.

2.2.2 ENGINE MOUNTS

The left engine mount remained attached to the airframe and there was no evidence of looseness at its attachment points (**Figure 5**). The left engine mount's lower link was fractured on the side closest to the engine's mount pad. The airframe attaching hardware installation conformed to the MDHI 369-series aircraft maintenance manual (AMM). On the upper link's bolted connection to the airframe fitting, the bolt head was observed to be on the obtuse-angle side of the fitting while the nut was observed to be on the acute-angled side of the fitting. Additionally, the thicker washer was underneath the bolt head while the thinner washer was underneath the nut.

The right engine mount remained attached to the airframe and there was no evidence of looseness at its attachment points. The right engine mount's upper link was bent to the right at the adjustment nut connection. On the upper link's bolted connection to the airframe fitting, the bolt head was observed to be on the obtuse-angled side of the fitting and the nut was observed to be on the acute-angled side of the fitting. Additionally, the thicker washer was underneath the bolt head and the thinner washer was underneath the nut.

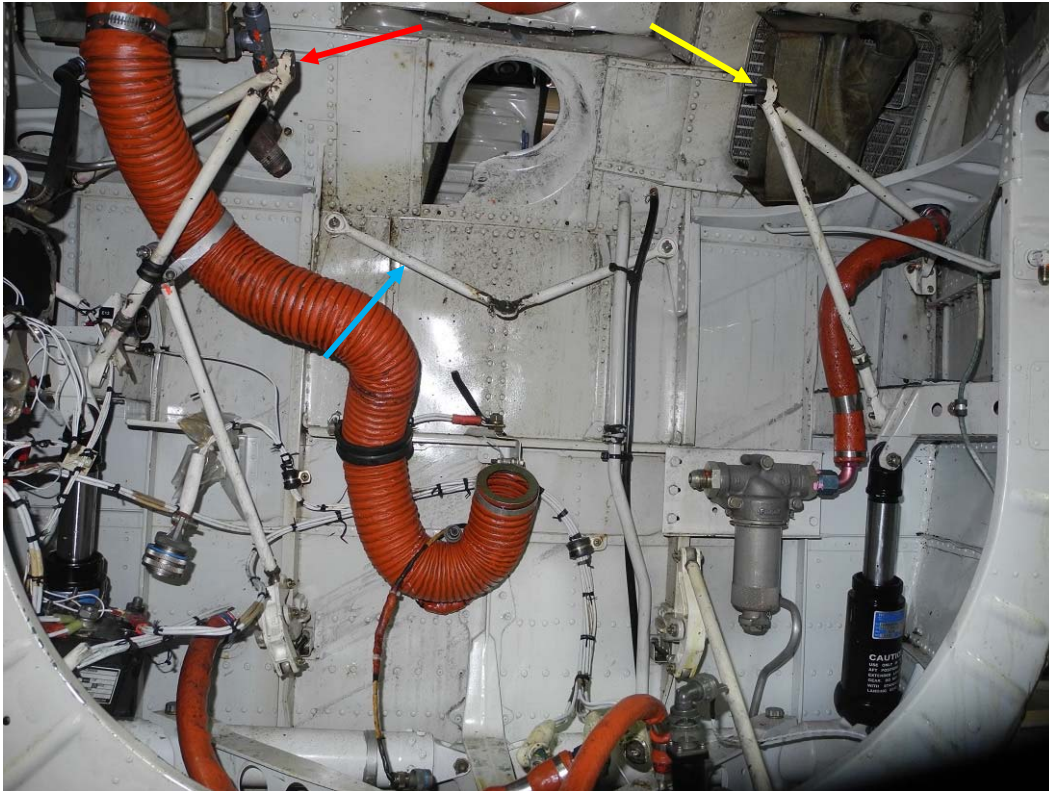


Figure 5. The left (red arrow), center (blue arrow), and right (yellow arrow) engine mounts as installed on the airframe.

The center engine mount remained attached to the airframe and there was no evidence of looseness at its attachment points. The center engine mount, while still installed on the airframe, exhibited no evidence of visible fractures. The airframe attaching hardware installation conformed to the MDHI 369-series AMM. The thicker washers were underneath the nuts and the thinner washers were underneath the bolt heads.

The engine mounts were shipped to the NTSB Materials Laboratory in Washington, DC for further examination. (See section 4.0 of this report for additional details of the engine mount examination.)

3.0 OVERRUNNING CLUTCH

According to the MDHI 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 overrunning clutch subassembly include the outer race, inner race, sprag clutch assembly, the forward and aft sprag bearings, and the output bearing. Adding the clutch housing and retaining ring converts the overrunning clutch subassembly into the next higher level assembly, the overrunning clutch assembly.

The overrunning clutch assembly was examined by the NTSB Materials Laboratory in Washington, DC. Metallurgical examination of the clutch subassembly fracture surfaces revealed evidence of fatigue and torsional overload. Additional information on the lab examination findings for the overrunning clutch assembly can be found in Materials Laboratory Factual Report No. 19-058 in the docket for this investigation.

3.1 OVERRUNNING CLUTCH INSTALLATION ON N89ZC

The overrunning clutch subassembly installed on the accident helicopter was part number (P/N) 369A5350-51 and S/N 3096G41. According to its service component record, the clutch subassembly was installed onto the accident helicopter on February 18, 2019 at ATT of 13,637.0 hours. Additionally, the record showed the clutch subassembly had a component time since new (CTSN) of 13,583.3 hours and a component time since overhaul (CTSO) of 1,307.7 hours. [Table 1](#) shows the last 4 overrunning clutch subassembly installations on N89ZC.

Table 1. Installation history of the last 4 overrunning clutch subassemblies on N89ZC.

Clutch S/N	Date Installed	ATT at Installation	Date Removed	ATT at Removal
HT6701	June 14, 2018	13,190.7 hours	September 6, 2018	13,342.3 hours
HT14758	September 6, 2018	13,342.3 hours	October 24, 2018	13,458.5 hours
HT6701	October 24, 2018	13,458.5 hours	February 18, 2019	13,637.0 hours
3096G41	February 18, 2019	13,637.0 hours	(March 5, 2019) ¹	(13,671.3 hours) ¹

3.2 CLUTCH SUBASSEMBLY S/N 3096G41 HISTORY

According to the component service record for clutch subassembly S/N 3096G41, prior to its installation on the accident helicopter, the clutch subassembly was last installed on N112AS on September 3, 2018. The clutch subassembly was removed from N112AS on November 12, 2018, with the record listing Airworthiness Directive (AD) 90-19-02 as the reason for removal.² The clutch subassembly was subsequently sent to Heli-Tech, Inc. in Panama City, Florida, for inspection under work order No. 17504. A 300-hour sprag bearing inspection and bearing [grease] repack were performed. The clutch subassembly's inner and outer races were

¹ March 5, 2019 was the date of the accident. The calculated ATT at removal was based on the Hobbs meter observation from the wreckage and maintenance records that listed both ATT and Hobbs times.

² FAA AD 90-19-02 contains several required actions for certain overrunning clutch assemblies, including a recurrent inspections at intervals not to exceed 300 hours time in service or at an annual inspections, whichever occurs first.

magnetic particle inspected on December 3, 2018. The magnetic particle inspection did not find evidence of cracks on the inner race. However, the magnetic particle inspection found evidence of cracks at the base of the splines of the outer race. This outer race was P/N 369A5352-5 and S/N 012033-0351. As a result, a new outer race, P/N 369A5352-5 and S/N 5304-1012, was installed onto clutch subassembly S/N 3096G41 under work order No. 17504. At the completion of these repairs, an airworthiness approval tag was generated on January 15, 2019. Attachment 1 contains the FAA Form 8130-3 (airworthiness approval tag) for the repairs performed on clutch subassembly S/N 3096G41.

4.0 ENGINE MOUNTS

The engine mounts were examined by the NTSB Materials Laboratory in Washington, DC. Metallurgical examination of the engine mounts found fractures on all three mounts. The left engine mount had a fracture and deformation consistent with tension overload on both arms of the engine mount, while the right engine mount had a fracture and deformation consistent with compression overload on its upper arm and tension overload on its lower arm. The center engine mount had deformation and fractures on both arms. Additional information on the lab examination findings for the engine mounts can be found in Materials Laboratory Factual Report No. 19-057 in the docket for this investigation.

4.1 ENGINE MOUNT INSTALLATION ON N89ZC

Based on the available maintenance records, the date of installation of the engine mounts could not be determined. According to MD Helicopters Maintenance Manual No. CSP-HMI-2, the engine mounts are not life limited components and are replaced on condition.

4.2 ENGINE MOUNT INSPECTION HISTORY

Chapter 5 of MD Helicopters Maintenance Manual No. CSP-HMI-2 contains instructions for periodic, special, and conditional inspections. **Table 2** contains an excerpt of the 100-hour or annual inspection requirements for the engine. The engine is not required to be removed to facilitate this inspection. Conditional inspections of the engine mounts are performed based on certain events, such as a hard landing or a main rotor sudden stoppage. The special inspections do not contain criteria specifically for inspecting the engine mounts.

Table 2. Excerpt of the 100-hour/annual inspection requirements for the engine.

Requirement	Chapter/Section
Entire engine for:	71
- Loose bolts; loose or broken connections.	75
- Accessories for security and broken or missing lockwire.	76
- Fuel and oil lines for chafing and kinking.	
- Fuel drain line valve for leakage.	
- Oil cooler and cooler deflector for security and obvious damage.	
- Accessible areas for obvious damage; evidence of fuel and oil leaks.	
- Engine mounts for cracks and play in mounting hardware at engine and airframe (retorque any loose mounting bolts).	
- Fuel control and compressor exterior for condition and security.	

Section 71-20-00, "Engine Mounts," provides instructions for inspecting the engine mounts and fittings. These inspections include a visual inspection for straightness and for cracks or evidence of corrosion on the tubes and welded joints. The instructions state to magnetic particle inspect suspect engine mount assemblies.

Table 3 shows the 100-hour/annual inspections performed on N89ZC, with the most recent inspection performed on February 18, 2019. The records for these inspections contained no entries related to any defects or discrepancies noted with the engine mounts.

Table 3. 100-hour/annual inspection history on N89ZC.

Date of inspection	ATT at inspection
February 18, 2019	13,637.0 hours
December 16, 2018	13,549.9 hours
November 6, 2018	13,483.5 hours
October 12, 2018	13,413.5 hours
September 18, 2018	13,342.3 hours
July 12, 2018	13,277.3 hours

5.0 ENGINE-TO-TRANSMISSION DRIVESHAFT

Visual examination of the driveshaft showed no evidence of fractures (**Figure 6**). The engine-to-transmission driveshaft installed on the accident helicopter was P/N E500N5215 and S/N KAM1-131. The driveshaft was installed on the accident helicopter on September 18, 2018 at an ATT of 13,342.3 hours.



Figure 6. The engine-to-transmission driveshaft after removal from the accident helicopter.

The engine-to-transmission driveshaft was retained by the NTSB and subsequently examined at Kaman facilities in Bloomfield, Connecticut in April 2020. Visual examination of the driveshaft showed no evidence of fractures. The driveshaft length was measured to be about 15.264 inches, which was within the allowable range of length. The driveshaft wall surrounding the anti-flail element showed evidence of contact but no evidence of transmitting torque while relying on the anti-flail element.

The perpendicularity of the driveshaft end fittings to the shaft was measured to be between 0.25-0.27 degrees. The measured perpendicularity had increased from the perpendicularity at the time of the driveshaft assembly's manufacture, which was between 0.08-0.12 degrees. The driveshaft was placed on an axial spring rate testing setup to measure load versus axial deflection and assess the functionality of the driveshaft's flexible elements. The measured axial spring rate was within 3% of the designed axial spring rate.

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