National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594

WPR22FA101

AIRWORTHINESS

Group Chair's Factual Report

December 21, 2022

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A. ACCIDENT

Location: Newport Beach, CA
Date: February 19, 2022
Time: 1833 Pacific standard time (PST)
0233 universal coordinated time (UTC)
Helicopter: MD Helicopter / 500N / N521HB

B. AIRWORTHINESS GROUP

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C. DETAILS OF THE EXAMINATION

1.0 Helicopter Information[1]

The MD 500N helicopter is a 5 seat, turbine powered, rotary-wing aircraft constructed primarily of aluminum alloy while the tailboom and thruster are primarily a graphite composite with a maximum gross weight of 3,350 pounds. The main rotor is a fully articulated five bladed system, with anti-torque provided by the NOTAR (no tail rotor) fan system. Power from the turboshaft engine is transmitted through the

[1] MD 520N (500N) Rotorcraft Flight Manual, 1-11

main drive shaft to the main rotor transmission, from the main transmission through a drive shaft to the aft transmission and through a second drive shaft to the NOTAR fan. An overrunning (one-way) clutch, placed between the engine and main rotor transmission permits free-wheeling of the rotor system during autorotation.

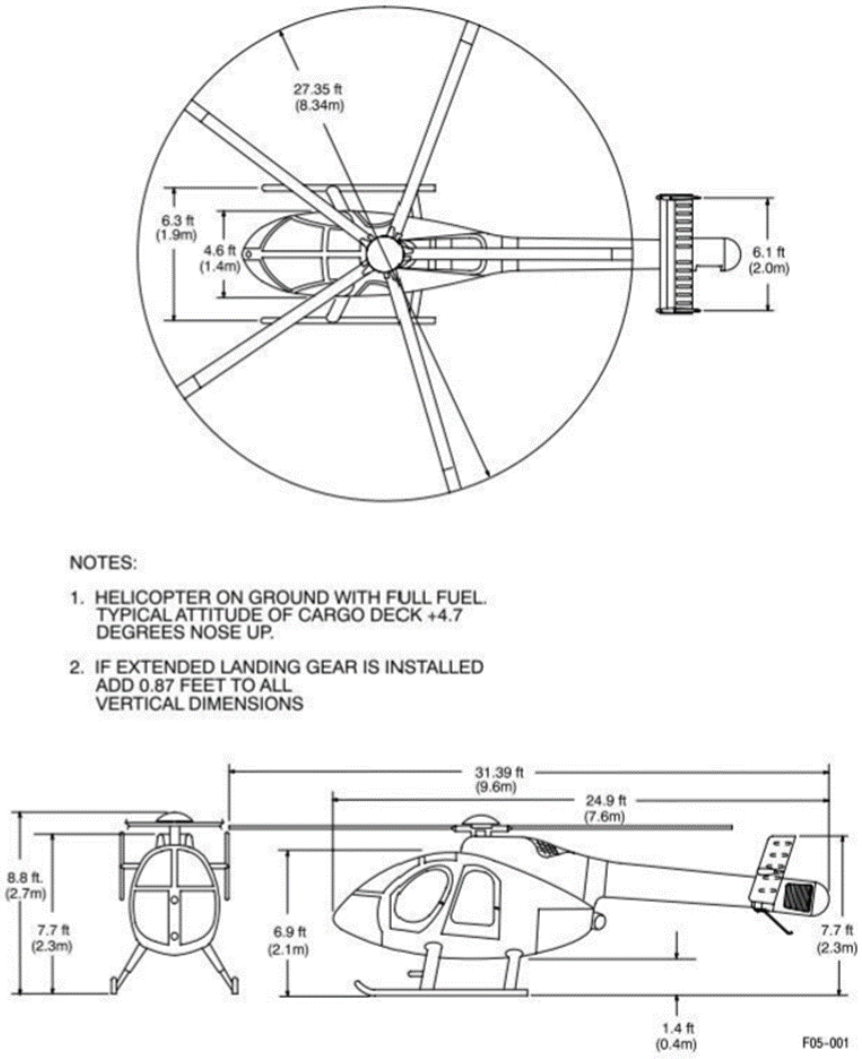

Figure 1. 3-view diagram of the MD 500N helicopter (Source: MD Helicopters).

2.0 On Scene Wreckage Documentation

Wreckage was submerged in salt water about 15 yards off the southwest end of the Lido Peninsula, Newport Beach, CA. A crane lifted the helicopter out of the water by the rotor head. The wreckage was dewatered, and 2 rotor blades were removed by pulling the blade retention pins. Two rotor blades had separated from the rotor head and the Orange County Sheriff Dive Team recovered both blades in the vicinity of initial water impact. The fifth blade remained on the helicopter during transport to the wreckage examination facility. The helicopter was transported via flatbed tractor trailer truck to a temporary storage location in Costa Mesa, CA. The entire helicopter was recovered, minus some wind screen fragments.

The fuselage was intact, with landing skids, cockpit, cabin, and tailboom. The horizontal and vertical stabilizer assembly mounts had fractured. The stinger remained attached to the tail and had been displaced to the left. Main rotor was attached to the mast, and 3 of the 5 rotor blades remained attached to the rotor head (Figure 2).

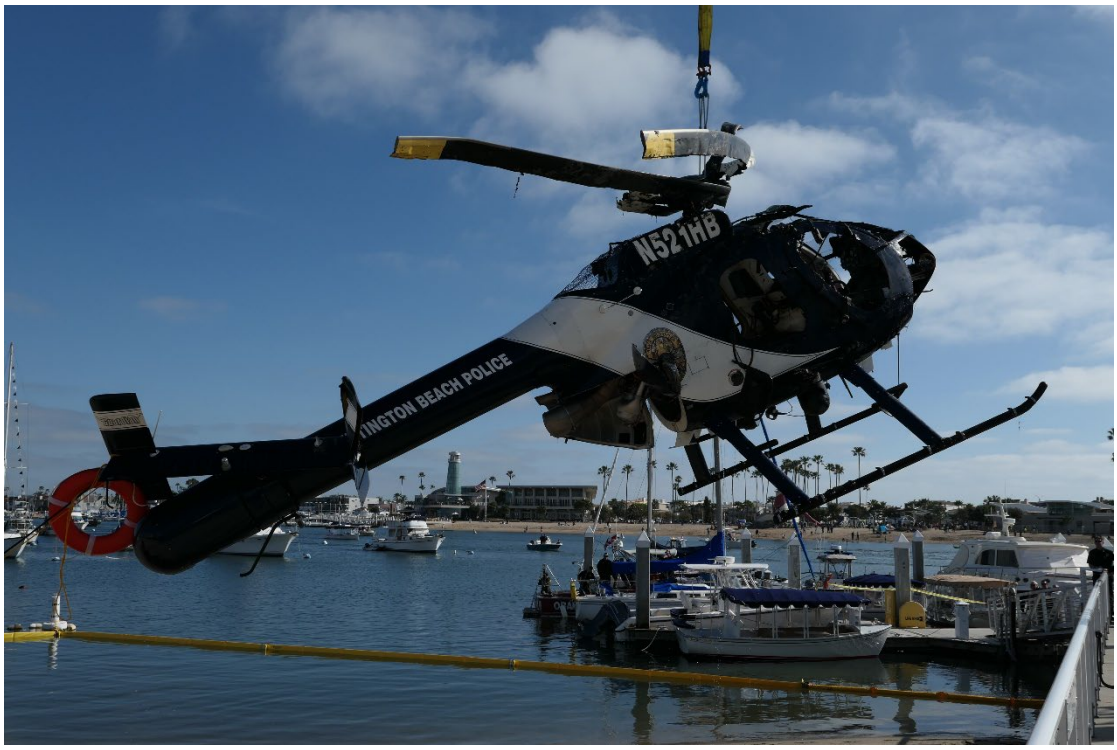

Figure 2. Helicopter being lifted out of the water.

3.0 Wreckage Examination

3.1 Cockpit

The cabin was intact. The wind screen on both pilot and copilot sides had broken out leaving only the frame. The front frame was fractured just below the upper deck. Both cyclics and collectives were in place. The left cockpit had the antitorque pedals installed, but the right cockpit's were not. Figure 3 is a photo of the instrument panel as found.

Figure 3. Cockpit instrument panel.

Table 1. Instrument readings.

Airspeed	110 knots (kts)
Nr (main rotor speed)	0% revolutions per minute (rpm)
Altitude	2,000 feet (ft)/ 1016 millibar (mb)
Vertical Speed Indicator (VSI)	0 feet per minute (fpm)
Nf (engine power turbine speed)	0% rpm
Turbine Outlet Temp (TOT)	0° C
Torque	0 pounds per square inch (psi)
Engine Oil Temp	0° C
Oil Pressure	0 psi
Fuel Quantity	0 pounds (lbs)
Direct Current (DC) Amps	0 amps
Battery	ON
Generator (Gen)	ON
Radio Master	ON

YSAS[2]	ON
Scavenge Air	OFF
Anti-ice	OFF
Hobbs	6,799.5 Hours
Maintenance (Mx) Hobbs	5,028.7 Hours
Emergency Locator Transmitter (ELT)	Armed

Both seat bases and seat pans were intact, attached to the airframe, and did not exhibit any evidence of crush damage. Both the pilot and copilot's (tactical flight officer (TFO -left) seatbelts were found unbuckled. All belts remained attached to their airframe anchor points. The pilot's shoulder harness webbing could be moved freely in and out of its inertial reel. The TFO's shoulder harness webbing was bound at the inertial reel entry, and the webbing appeared frayed and crimped at the reel.

3.2 Flight Controls

Cyclic continuity was confirmed from both pilot and copilot's cyclic to the stationary swash plate (Figure 4). Lateral and longitudinal pitch control rods were all connected from the cockpit, lower control connections in the broom closet, and the upper control connections (upper broom closet). Both cyclic control rods (lateral and longitudinal) were connected to the upper bell cranks. Lateral cyclic mixer bell crank had been liberated from the stationary swash plate. Both swash plate links were fractured at the lower ends.

Collective continuity was confirmed from both pilot and copilot's collective from the cockpit to the stationary swash plate (Figure 4). The collective control rod was connected from the cockpit to the lower control connections in the broom closet, and to the upper control connections (upper broom closet). The collective control rod was connected to the upper bell crank. The drive link was fractured at the slider but remained attached to the stationary swash plate.

[2] YSAS – A Yaw Stability Augmentation System (YSAS) controls the right vertical stabilizer and is driven by a small electro-mechanical actuator mounted within the horizontal stabilizer. The right stabilizer moves through approximately 15 degrees of motion. Signals for the YSAS are obtained from a yaw rate gyro and lateral accelerometer mounted under the right pilot seat. The YSAS is installed to enhance handling qualities.

Figure 4. Photo of the upper control connections.

Anti-torque system continuity from the pilot's pedals to the rotating cone and left vertical stabilizer bell crank was confirmed. The anti-torque fan blades changed pitch in concert when anti-torque pedals were moved. The pilot and copilot pedal control rods were all connected from the cockpit to the lower control connections in the broom closet, and to the upper control connections (upper broom closet). The anti-torque control rod was connected to the upper bell crank, and the anti-torque sector. The splitter assembly remained in place with all connections in place. The morse cable (teleflex) cable remained connected to the anti-torque sector via the forward to aft cable connection (Figure 5).

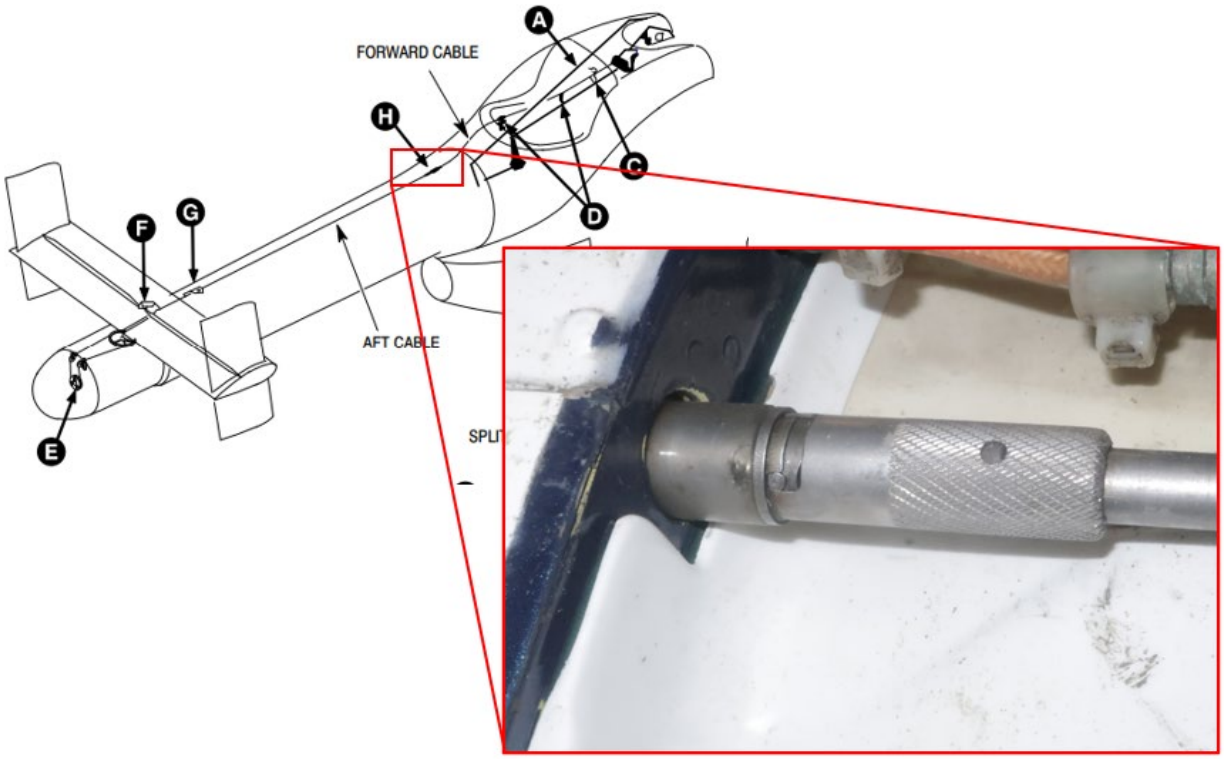

Figure 5[3]**.** Forward to aft cable connection (Source: MD Helicopters).

3.3 Main Rotor Blades

The blue blade, part number (PN) 500P2300-503, serial number (SN) T697, remained attached to the rotor head. The blade was bent aft about 12 inches outboard of the blade attach pins, exhibited a shallow s-bend along its length, and the trailing edge had split open.

The yellow blade (Figure 6), PN 500P2300-505, SN 634T, the entire blade remained attached to the rotor hub. There was a chord wise fracture about 12 inches outboard of the blade attach pins and a longitudinal s-bend along the entire length of blade. There was trailing edge buckling along the entire length and the trailing edge was split open.

The green blade (Figure 6), PN 500P2300-505, SN 681T, and pitch change housing had separated from the hub with fracture signatures consistent with overload. The blade was attached to its housing with both blade pins. The tension torsion (TT) straps were present on the housing, deformed, and separated in shear. The pitch change link was attached to the pitch change arm and the opposite end rod end was bent and fractured. The blade damper was attached to the housing, and the damper arm was not present. The damper arm clevis was not present on the

[3] Tail boom drawing extracted from MD maintenance manual 67-20-30.

blade, but the attachment flange and bearing were present. The blade was deformed in a downward arc and bent aft about 20°, 12 inches outboard of the blade pins. There was trailing edge buckling along the entire length and the trailing edge was split open.

The red blade (Figure 6), PN 500P2300-505, SN 632T, had separated with a 45° fracture line about 12 inches outboard of the blade attachment pins. The blade was curved downward in a single arc. There was trailing edge buckling along the entire length and the trailing edge was split open.

The white blade (Figure 6), PN 500P2300-505, SN 692T, remained attached to the rotor hub. The damper rod clevis was attached to the blade root trailing edge, its rod was fractured at the nut. The blade was bent aft about 30°, 12-inches outboard of the blade pins. There was lengthwise trailing edge buckling and the trailing edge was split open the entire length of the blade. Three feet of the blade tip was deformed downward.

Figure 6. Rotor blades and horizontal stabilizer laid out. The blue blade remained connected to the main rotor hub.

3.4 Horizontal and vertical stabilizers

The horizontal and vertical stabilizer assembly (Figure 7) mounts had broken from the tail boom in a right to left direction, but the assembly remained connected by the YSAS electrical cables. The left vertical stabilizer center control bell crank had fractured at the push-pull rod attach clevis. The left vertical stabilizer control linkages were connected, and continuity was established thru the fractured bell crank. A yellow rescue line had jammed into the left vertical stabilizer bearing/hinge. The left vertical control linkage had separated from the bell crank, the fracture surface was bright and granular in texture, consistent with overload. The left vertical stabilizer rotated on its hinge freely. The right vertical stabilizer exhibited surface fractures, and the upper portion was split along the trailing edge. The YSAS actuator was extended 2.8 cm from actuator to the rod end plate. Safety wire was not present on the actuator bolt; however, the bolt was found to be torqued tight when investigators removed the actuator.

Figure 7. Horizontal and vertical stabilizer assembly.

3.5 Antitorque system

The tail boom remained attached to the fuselage. The NOTAR fan drive shaft was connected at both ends via KAflex couplings with no visible damage (Figure 8).

The drive shaft and fan rotated in concert with the main rotor and gearbox. The pitch on all fan blades appeared similar and moved in concert with pedal application (Figure 9). Anti-torque system rigging was verified by confirming all 3 rigging pin locations could be lined up and pinned simultaneously. The fan pitch rigging was verified as set to 27°.

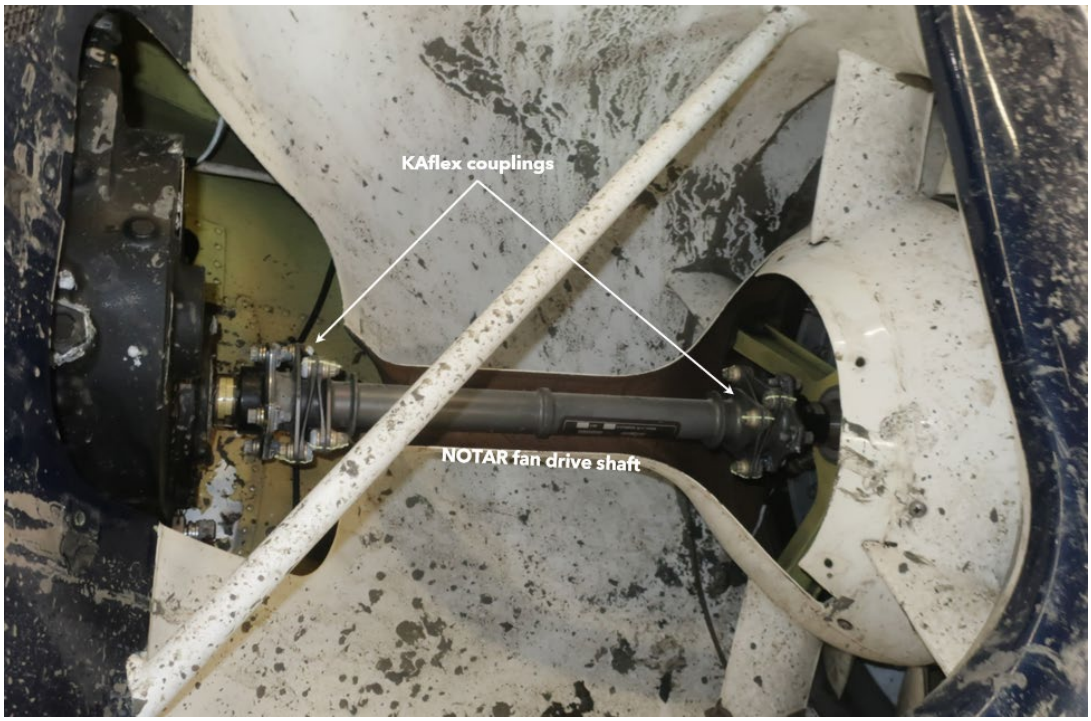

Figure 8. NOTAR fan drive shaft.

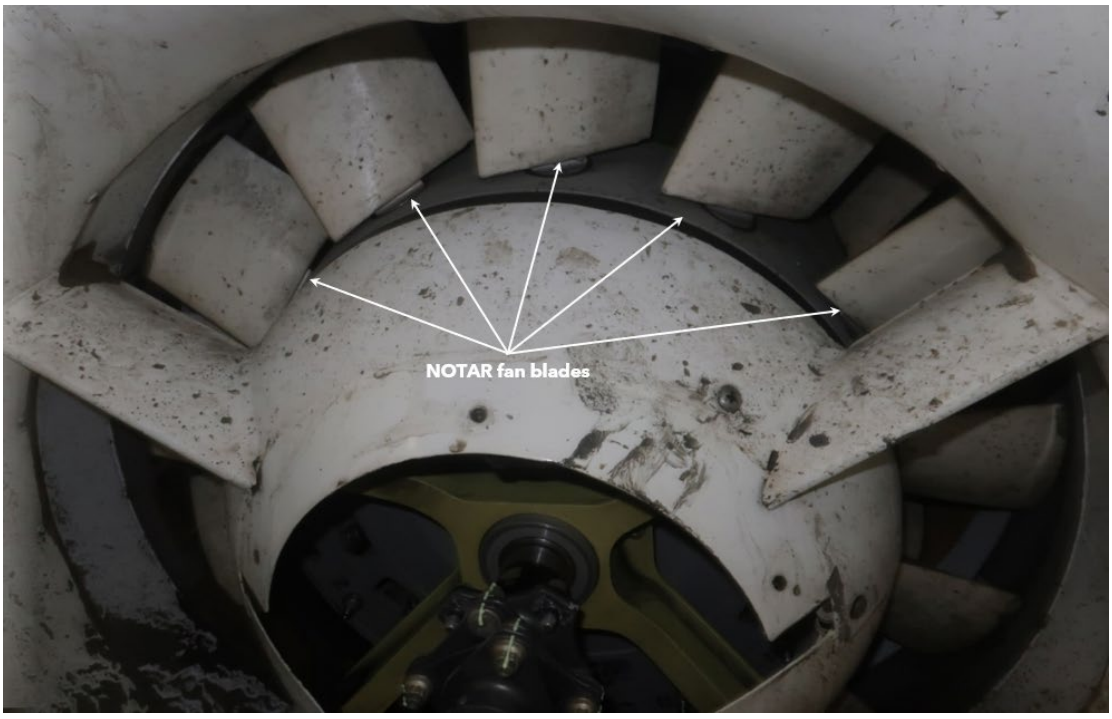

Figure 9. NOTAR fan

The rotating cone exhibited external damage on its upper surface (Figure 10), deforming the bearing ring at one location, and had been displaced aft off the roller bearings. The cone thrust opening was measured about 5.5 inches. The 3 bolts retaining the cone were in place, keeping the cone attached to the drum assembly. The tail boom assembly interior was clear of debris. No internal damage was observed. The tail duct inlet area has 11 guide vanes, none of which exhibited damage. The central forward diffuser cone was undamaged, no debris observed. The stationary thruster was attached and all thruster vanes in place. The aft control rod was connected the aft sector assembly, cables remained attached and routed to the rotating cone assembly through the idler pully.

Figure 10. Rotating cone.

3.6 Engine

The engine was a Rolls-Royce 250 series, model C20R, SN CAE-835590. The engine compartment bay doors were both open, the engine remained attached to its mounts, and appeared to be undamaged. All fuel supply lines were intact at their respective fittings, and there was no evidence of leaks. All pneumatic lines were also intact at their respective fittings, with no evidence of line damage, failure, or breach. The fuel filter bypass valve did not appear to have been activated, and fuel was present in the line from the fuel controller to the fuel nozzle on the combustor outer case. Both collective controls remained connected to each other and were found in the down position. The control linkages were continuous to the governor, and movement of the collective resulted in the appropriate movement of its respective governor input control arm. The collective twist grip control linkage was continuous to the engine fuel controller, and rotation between the flight, idle, and off positions

correlated to the appropriate positions at the fuel control input arm. Removal of the exhaust shroud gave access to the 4th stage turbine wheel. The exhaust shroud was undamaged, and visual examination within the engine did not reveal any evidence of catastrophic failure, blade damage, or liberation. The 4th stage turbine wheel could be rotated by hand in one direction with corresponding movement of the main rotor system, and in the other direction no movement was observed consistent with disengagement of the freewheeling clutch. The accessory gearbox vent hose was removed, and water and oil flowed from its end. The engine was not removed from the airframe and no other examinations were conducted.

4.0 Maintenance Records Review

The maintenance records for the 11 months preceding the accident were reviewed and summarized in Table 2.

Table 2. Maintenance history.

Date	ACTT	Activity Summary
2/19/22	15,028.1	A-check[4]. Last maintenance log entry.
2/15/22	15,022.8	MD 300-hour inspection. Lead-lag 4,200 hour inspection, fuel nozzle clean, main rotor blade (MRB) root end inspection, fuel pump inspection, MRB torque inspection, MRB corrosion inspection, TR torque tube inspection, regrease YSAS actuator. Overhauled splitter assembly. MD 100 hour inspection. Engine air plenum, tailboom inspection, thruster cone inspection, horizontal & vertical stabilizer inspection, landing gear, cabin inspection, main rotor (MR) controls and hub inspection, main transmission inspection, NOTAR system inspection, electrical system inspection, engine compartment inspection. Engine breather kit 100 hour. Night vision goggle (NVG) inferred filter system 100 hour. Rolls-Royce 100- and 300-hour inspection. Removed and replaced fan drive shaft, and Kamatics driveshafts.
1/31/22	15,010.1	Complied with MDHI 14SEC41 letter (HTC Notice No. 2100-5) for blade root inspection. No defects
12/13/21	14,921.6	MD 100-hour and yearly inspection. Rolls-Royce 100-hour inspection. Engine breather kit 100 hour, NVG inferred filter system 100 hour. Removed and replaced vertical stabilizer, removed, and replaced generator control unit (GCU), removed and replaced cyclic torque tube
10/29/21	14,828.1	MD 100-hour inspection. Rolls-Royce 100-hour inspection. Engine breather kit 100 hour, NVG inferred filter system 100 hour. Turbine section repaired for N2 lockup.
9/16/21	14,721.3	MD 600-hour inspection. Rolls-Royce 600-hour inspection. Parts received: pitch plate assembly. NOTAR fan hub, fan blades (13), tension-torsion straps (10), numerous fasteners, bushings. 2 retention

[4]HBPD refers to the A-check as a daily inspection to include any recurrent ADs or service bulletin inspections.

		plates. 2 pitch horn assy. Engine breather kit 100 hour, NVG inferred filter system 100 hour.
7/16/21	14,622.8	MD 100-hour inspection. Rolls-Royce 100-hour inspection. removed and replaced oil cooler blower. Engine breather kit 100 hour, NVG inferred filter system 100 hour.
5/29/21	14,526.3	MD 200-hour inspection. Rolls-Royce 100-hour inspection. Engine breather kit 100 hour, NVG inferred filter system 100 hour.
4/23/21	14,423.3	MD 100- & 300-hour inspection. Rolls-Royce 300-hour inspection. Engine breather kit 100 hour, NVG inferred filter system 100 hour.
10/21/20	14,125.0	Engine installed on N521HB
7/27/20	N/A	Engine compressor, gearbox, and turbine overhauled (HEROS Inc, Chandler AZ)

All applicable Airworthiness Directives (ADs) or service bulletins associated with an AD were found to have been complied with.

Submitted by:

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