

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



ERA23FA070

AIRWORTHINESS

Group Chair's Factual Report

December 22, 2022

A. ACCIDENT

Location: Charlotte, NC
Date: November 22, 2022
Time: 1219 EST
1719 UTC
Helicopter: Robinson R44 / N7094J

B. AIRWORTHINESS GROUP

Group Chairman	Van S. McKenny IV NTSB-AS40 Washington, DC
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C. DETAILS OF THE EXAMINATION

1.0 Helicopter information

1.1 Helicopter Description¹

The R44 helicopter is a four seat, single main rotor, single engine helicopter, constructed primarily of metal and equipped with skid-type landing gear (Figure 1). The primary fuselage structure is welded steel tubing and riveted aluminum sheet.

¹ Robinson model R44 Pilot's Operating Manual, Section 7.
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The tail cone is monocoque structure in which aluminum skins carry most primary loads. Fiberglass and thermoplastics are used in secondary cabin structure, engine cooling shrouds, and various other ducts and fairings. The cabin doors are also constructed of fiberglass and thermoplastics.

Four right-side cowl doors provide access to the main gearbox, drive system, and engine. A left-side engine cowl door provides access to engine oil filler and dip stick. Additional access to controls and other components for maintenance is provided by removable panels and cowlings. Stainless steel firewalls are located forward of and above the engine.

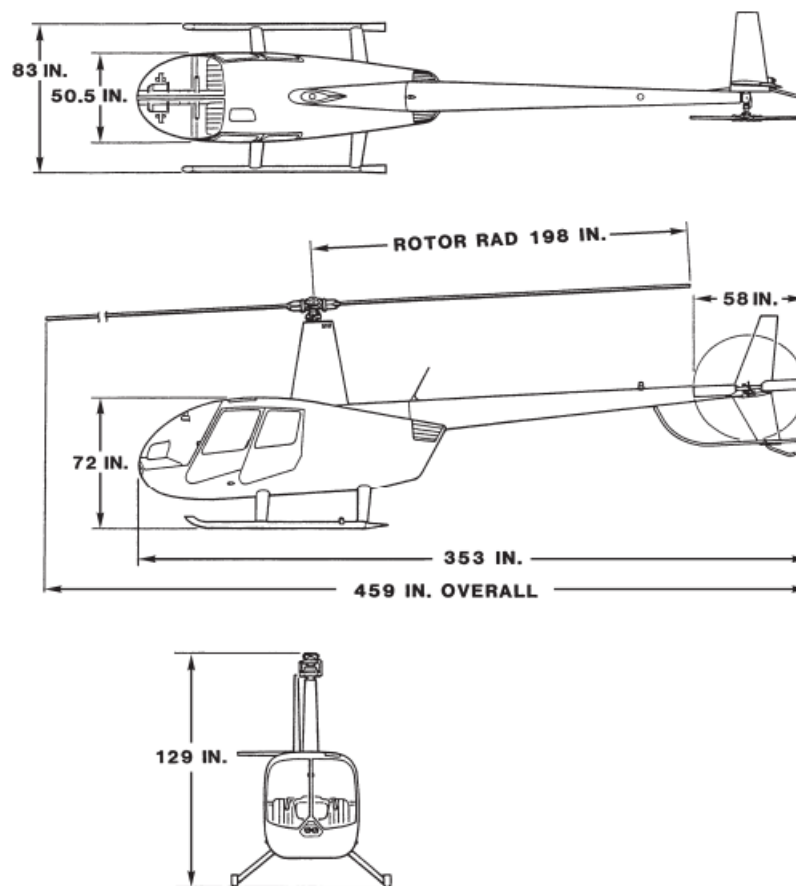


Figure 1. Three-view of the R44 helicopter (Source: Robinson Helicopter Company).

1.2 Accident Helicopter History

The helicopter, serial number 0600, was manufactured by the Robinson Helicopter Company in 1999. It was procured by Metro Networks Communications Inc. on June 10, 1999, and registered as N7094J. The helicopter was operated in electronic news gathering (ENG) and was equipped with a remote electro-optical

camera and various recording and transmitting electronic hardware. The helicopter had accumulated 13,560.1 hours aircraft total time (ACTT) at the time of the accident.

Table 1. Summary of maintenance activity since the helicopter was field overhauled.

Date	ACTT	Summary
10/21/2022	13,541.10	Replaced damaged main rotor pitch link on blade "A". Performed track and balance.
10/16/2022	13,537.50	100/300-hour annual inspection.
6/26/2022	13,447.60	100/400-hour annual inspection.
5/14/2022	13,413.60	Intermittent start. Starter found full of engine oil. Replaced starter.
2/27/2022	13,357.40	100-hour annual inspection.
10/24/2021	13,275.50	100/300-hour annual inspection.
6/6/2021	13,176.70	100/500-hour annual inspection.
2/7/2021	13,079.80	100-hour annual inspection.
9/6/2020	12,983.10	100/300-hour annual inspection.
5/31/2020	12,887.90	100-hour annual inspection.
1/26/2020	12,809.90	100-hour annual inspection.
8/15/2019	12,719.00	Helicopter field overhauled in accordance with RHC maintenance instructions. Lycoming O-540-F1B5, SN: RL-25747-40E installed.

2.0 Wreckage Documentation

The wreckage was examined at the Atlanta Air Recovery facility in Griffin, Georgia, on December 1st and 2nd, 2022 (Figure 2).



Figure 2. Main wreckage after recovery from the accident site.

The cabin area was completely collapsed downward with a flat upward crushing of the entire belly. The rotor, transmission, and rotor mast were attached to the airframe but displaced forward 90° rotated about the base of the transmission. The transmission/rotor mast assembly remained intact. The aft right-side door remained attached to the door frame. The pilot and copilot seats and their seat supports were collapsed downward. Extensive amounts of ENG equipment was contained in the cabin area behind the cockpit. The cockpit instrument panel was detached from the airframe but remained in the forward cabin area. The tail boom was attached to the aft airframe structure and extended 7 feet to a separation at the aft section of tail boom bay 4. The tail rotor drive shaft and tail rotor control rod had been cut by recovery personnel at the same location. The separated section of tail boom (approximately 6 feet) had the vertical and horizontal stabilizers attached, along with the tail rotor gear box and tail rotor assembly.

Both landing skids had separated from the fuselage. The right aft strut was attached to the skid tube but had separated from the cross-tube fitting; the forward strut had separated from the skid tube and remained attached to the cross tube in the fuselage. The left aft strut had separated from the skid tube at the skid tube attachment; the strut and cross tube were recovered in one piece. The left forward strut had separated from the skid tube and remained in the fuselage; the skid tube toe had fractured. Both main and auxiliary (aux) fuel tanks had separated from the fuselage. Both tanks had bladders installed, both contained some fuel, and both fuel caps were in place. The engine remained within the engine compartment, but the engine mounts had fractured, and the engine was restrained by the drive belts. The drive sheave and fan were attached to the engine, and the associated baffling was in place. The 4 drive belts were present but had shifted off their respective grooves on the sheave. The engine starter ring had cut into the nearby metal baffling (Figure 3).

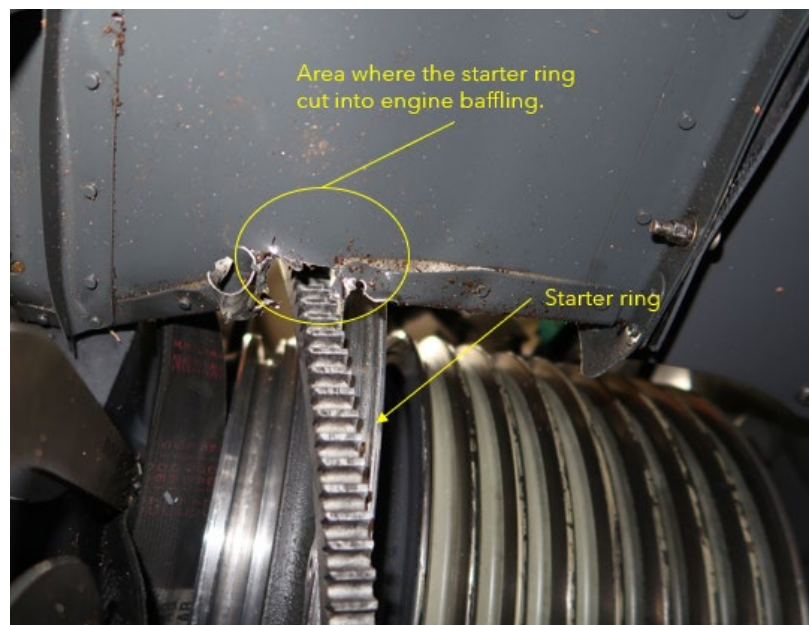


Figure 3. A close in photo of the area where the starter ring had cut into the engine baffling.

2.1 Cockpit and Instrumentation

Pilot side cyclic, collective, and antitorque pedals were identified in the cockpit. The cockpit seats exhibited seat pan crushing and seat frame deformation. The instrument panel instrument readings are listed in Table 2.

Table 2. Instrument Readings.

Instrument	Reading
VSI (vertical speed indicator)	400 feet per minute (fpm) climb
Airspeed	155 mph (needle off scale)
Altimeter	140 feet, 30.38 inches of mercury (inHg)
Engine rpm	0%
Rotor rpm	0%
Manifold Pressure	36 inHg (off scale)
Carburetor Temperature	No needle
Oil Pressure	0 pounds per square inch (psi)
Amps	40 amps
Oil Temperature	78° F
Aux Fuel (quantity)	½
Fuel (quantity)	F (full)
Oil Hydraulic Temp	Below 200° F (off scale)
Clutch switch	ENG (switch cover closed)
Magneto (key switch)	Between OFF & R
Navigation Lights	ON
Strobe Lights	ON
Clock	Hour hand at 11, minute hand detached.

2.2 Flight Controls

2.2.1 System Description²

Flight control operation is conventional, and all primary controls are actuated through push-pull tubes and bellcranks. The cyclic is center mounted with the left and right control grips mounted to a cross tube which pivots on the center cyclic post.

Hydraulically boosted main rotor flight controls eliminate cyclic and collective feedback forces. The hydraulic system consists of a pump, three servos, a reservoir, and interconnecting lines. Normal operating pressure is 450 to 500 pounds per square inch (psi). The pump is mounted on and driven by the main gearbox. A servo is connected to each of the three push-pull tubes that support the main rotor swashplate. The reservoir is mounted on the steel tube frame behind the main gearbox and includes a filter, pressure relief valve, and pilot-controlled pressure shut-off valve.

2.2.2 Flight Control Examination

Cyclic and collective control was established from the cockpit aft to the stationary swashplate through multiple breaks in the control tubes. All bell cranks and control tube rod end connections were present except for the upper forward left control rod to swashplate flange. The left forward control rod end connection to the stationary swashplate flange was not connected (Figures 4 and 5), with the attaching bolt, nut, and palnut fastening hardware missing. The rotating swash plate had witness marks on the forward rotating face and the underside in line with the left forward control tube rod end (Figure 6). The control tube rod end had witness marks on its outer diameter, the palnut fastener was not present, and the rod end was extended (unscrewed) 3/4 inch from the control rod. The upper forward portion of the rotor mast fairing and control rod had damage consistent with the control rod repeatedly impacting the interior of the fairing (Figure 7).

² Robinson model R44 Pilot's Operating Manual, Section 7
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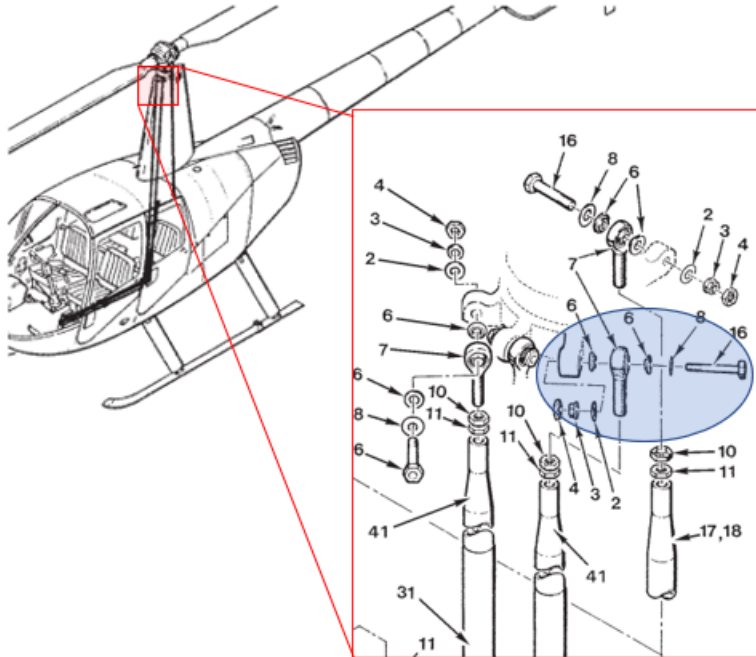


Figure 4. Location of left control rod disconnect highlighted by blue oval. (Source: Robinson Helicopter Company)



Figure 5. Photo of the upper controls showing the disconnected forward left control rod from the stationary swashplate.

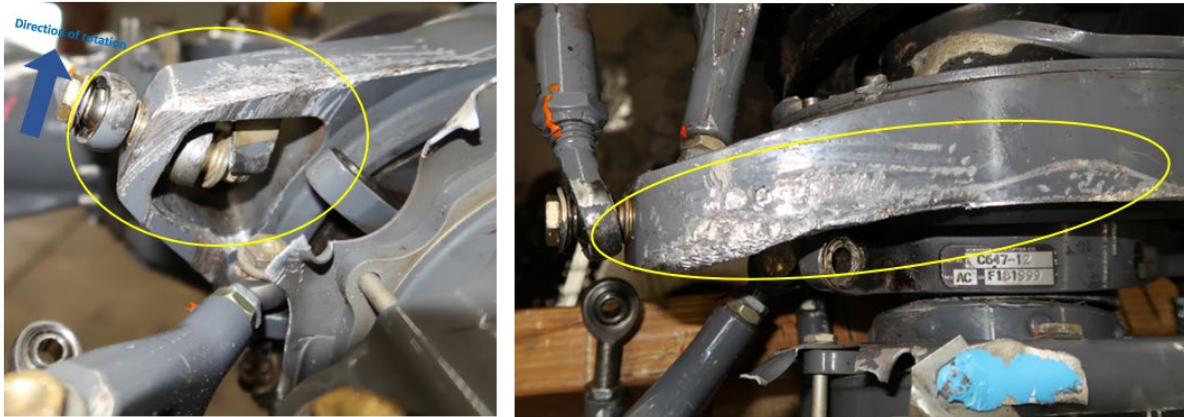


Figure 6. Witness marks identified by the yellow oval on the forward face of the rotating swashplate.

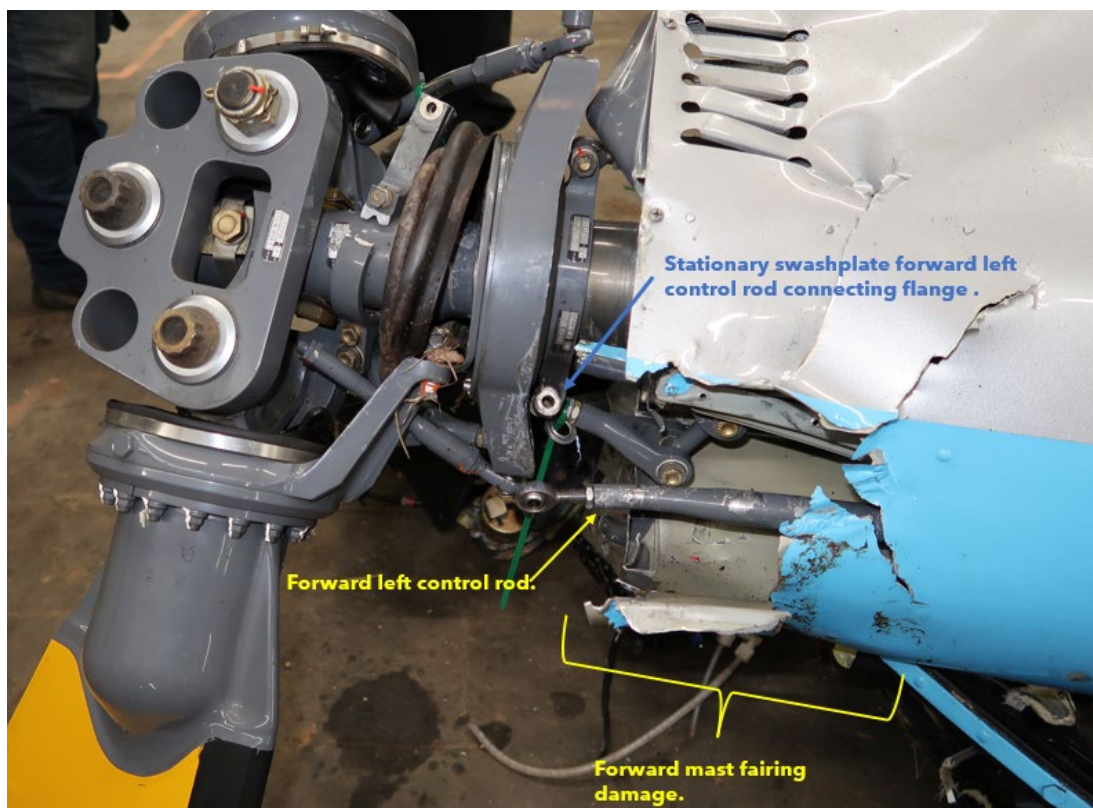


Figure 7. Upper portion of the mast fairing damage.

Both rotating and nonrotating scissors were connected to their respective swashplates. The counterbalance weight for the rotating scissors had been liberated. Both pitch links had been liberated from their respective blade pitch horns but remained attached to the rotating swashplate. Blade "A"'s pitch link rod end was attached to the pitch horn. Blade "B"'s rod end was attached to the pitch link and the bolt connecting the rod end to the pitch horn had sheared leaving a portion of the bolt in the pitch horn.

The hydraulic reservoir contained a small amount of hydraulic fluid. Hydraulic lines from the reservoir to the hydraulic pump remained connected. The teletemp sticker on the hydraulic pump read 200° F.

All 3 hydraulic servos (Table 3) had control rod connections attached at both ends. The aft and forward left servos could be actuated by hand, the right forward servo piston shaft was bent, limiting the travel when actuated.

Table 3. Flight control servo manufacturing information.

Item	Part Number (PN)	Revision	Serial Number (SN)
Right Forward Servo	PN: D212-1	Rev G	SN: 5614
Left Forward Servo	PN: D212-1	Rev F	SN: 2780A
Aft Servo	PN: D212-1	Rev I	SN: 11239

The tail rotor control tubes and linkages were continuous via breaks in the cockpit and tail boom. The tail rotor control rod at the tail rotor gear box had fractured at the bellcrank rod end. Both tail rotor pitch links were attached to each blade moved in concert when manipulated.

2.3 Main Rotor Drive System

2.3.1 System Description³

A vee-belt sheave is bolted directly to the engine output shaft. Vee-belts transmit power to the upper sheave which has an overrunning clutch contained in its hub. The inner shaft of the clutch transmits power forward to the main rotor and aft to the tail rotor. Flexible couplings are located at the main gearbox input and at each end of the long tail rotor drive shaft. The main gearbox contains a single-stage spiral-bevel gear set which is splash lubricated. Cooling ducts under the gearbox are connected to the top of the engine cooling scroll. The main gearbox is supported by four rubber mounts.

The long tail rotor drive shaft has no support bearings but has a lightly-loaded damper bearing. The tail gearbox contains a single 90° splash-lubricated spiral-bevel gear set.

2.3.2 Main Rotor Drive System Examination

The transmission rotated freely when manipulated by hand. The teletemp sticker read 230° F. The magnetic drain plug was clean of any particles.

³ Robinson model R44 Pilot's Operating Manual, Section 7
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The transmission drive shaft was connected to the transmission. The drive shaft sheave containing the freewheel unit was intact. The driveshaft-to- transmission flange was attached and deformed forward; the transmission had rotated 90° forward so that the rotor mast was positioned horizontally over the cockpit/cabin. The connecting flange did not exhibit torsional deformation. Once the drive shaft had been disconnected from the connecting flanges at both ends, the freewheel function was confirmed by rotating the sheave freewheeling in the clockwise direction and engaged in the counterclockwise (drive) direction.

All four drive belts were positioned around both sheaves. The Nos. 1 and 2 belts had parted. Nos. 3 and 4 were cut for removal from the wreckage. All belts exhibited no unusual wear patterns. Belts Nos. 3 and 4 had cuts and scuff marks along a 10-inch section consistent with entrapment between the sheave and airframe structure.

The belt tension actuator remained attached to the lower support bearing (engine) but had separated from the upper support bearing (transmission drive); the fracture surface had features consistent with an overload failure. Both bearings rotated smoothly.

The tail rotor drive shaft was connected to the transmission drive shaft and was continuous to the tail rotor gear box through the break in the tail boom. The tail rotor gear box rotated freely when manipulated by hand. The tail rotor gear box magnetic drain plug exhibited no particles.

2.4 Main Rotor.

2.4.1 System Description⁴

The main rotor has two all-metal blades mounted to the hub by coning hinges. The hub is mounted to the shaft by a teeter hinge. The coning and teeter hinges use self-lubricated bearings. Droop stops for the main rotor blades provide a teeter hinge friction restraint which normally prevents the rotor from teetering while starting or stopping. Pitch change bearings for each blade are enclosed in a housing at the blade root. The housing is filled with oil and sealed with an elastomeric boot. Each blade has a thick stainless-steel spar at the leading edge which is resistant to corrosion and erosion. The skins are bonded to the spar approximately one inch aft of the leading edge.

⁴ Robinson model R44 Pilot's Operating Manual, Section 7
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2.4.2 Main Rotor Examination

The rotor head, PN C154-1, SN 10963, remained attached to the rotor mast. Blade "A" had completely fractured chordwise 31 inches from the base of the spindle. Blade "B" was cut chordwise 27 inches from the base of the spindle by recovery personnel (Figure 8). Both mast bump stops exhibited crush damage across the middle.



Figure 8. Overhead view of both main rotor blades.

Blade "A", PN C016-7, Revision AJ, SN 10392; the entire blade was intact with a downward crease and a trailing edge buckle at 3 feet 6 inches from the fractured end. A second downward crease was 6 feet from the fractured end. The upper blade skin had buckling along the entire length and 45° angle creases along the leading edge of the outboard half of the blade. Only two inches of the tip cap trailing edge was present.

Blade "B", PN C016-7, Revision AJ, SN 10348; the entire blade had a distinct aft bend of the outboard half of the blade with trailing edge buckling. A 2-foot section of after body starting about 2 feet inboard of the blade tip had been liberated, which was characterized by blade skin tearing, peeling, and deformation. The entire tip cap remained attached to the blade.

2.5 Tail Rotor

2.5.1 System Description⁵

The tail rotor has two all-metal blades and a teetering hub with a fixed coning angle. The pitch change bearings have self-lubricated liners. The teeter hinge bearings either have self-lubricated liners or are elastomeric. The tail rotor blades are constructed with aluminum skins and root fittings.

⁵ Robinson model R44 Pilot's Operating Manual, Section 7
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2.5.2 Tail Rotor Examination

The tail rotor hub and blades were attached to the tail rotor gearbox and drive shaft. One blade was bent 90° outboard about 3 inches from the root, and a 45° bend inward at the tip. The other blade was straight and exhibited minimal damage. Both pitch change links were connected and moved in concert when the control rod end was manipulated. The control rod had fractured at the rod end fitting below the threads.

2.6 Engine

2.6.1 System Description⁶

A single Lycoming O-540 six-cylinder, horizontally opposed, overhead-valve, air-cooled, carbureted engine with a wet sump oil system powers the helicopter. The engine is equipped with a starter, alternator, shielded ignition, two magnetos, muffler, oil cooler, and induction air filter. A direct-drive, squirrel-cage fan wheel mounted to the engine output shaft supplies cooling air to the cylinders and oil cooler via a fiberglass and aluminum shroud. Induction air enters through an opening on the right side of the fuselage and passes through a flexible duct to the carburetor air box. A second flexible duct passes heated air from exhaust-mounted scoop to the air box. A sliding valve controlled by the carburetor heat control adjusts the mix of cool and heated air, which then flows through the air filter and up into the carburetor.

2.6.2 Engine Examination

The engine was a Lycoming, O-540-F1B5, SN RL-25747-40E, and the data plate listed takeoff power as 260 horsepower (hp) and normal power as 235 hp at 2,800 rpm. The engine had partially separated from the airframe, the starter ring gear had separated from the ring gear support and had cut into the cooling shroud. The engine was removed from the airframe and suspended for examination. The crankshaft was rotated by hand and thumb compression was achieved on all 6 cylinders. All 6 upper sparkplug electrodes and lower sparkplugs from cylinders 2, 4, and 6, were light gray in color with no mechanical damage observed. The lower sparkplugs from cylinders 1, 3, and 5 were oil soaked with no mechanical damage observed. The exhaust interior had a thin coating of a tan colored material. The oil sump suction screen was clear. Fuel was observed in the carburetor bowl and the carburetor finger screen was clear. The gascolator screen was 80% clear and the bowl had fuel in it. The gascolator fuel tested negative for water using water detection paste. The left magneto sparked when turned by hand, the right magneto

⁶ Robinson model R44 Pilot's Operating Manual, Section 7
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was impact damaged. The oil filter was cut open and no metallic particles were identified within the filter element folds.

3.0 Instrument caution/warning panel light bulb examination.

The light bulbs of all the caution/warning lights (Figure 9) were removed and submitted to the NTSB Materials Laboratory for examination. A normal light bulb filament is considered a filament resting in the support saddles with a slight curve of the filament between the supports. The following lights were examined by x-ray to determine filaments status. The status of each filament is listed in Table 4. Radiographs of selected light bulbs are included in this section (Figures 10, 11, and 12).



Figure 9. Caution and warning lights identified in yellow boxes.

Table 4. Caution/Warning Lights and observed filament condition.

Indicator Light	Filament Condition
Clutch	Intact, Stretched (Figure 11)
Rotor Brake	Intact, Not stretched
Main Rotor Gearbox Temp	Intact, Not stretched
Main Rotor Gearbox Chip	Intact, Not stretched
Carbon Monoxide	Intact, Not stretched
Starter On	Intact, Not stretched
Tail Rotor Gearbox Chip	Intact, Not stretched
Low Fuel	Intact, Not stretched
Low RPM (rotor)	Intact, Not stretched (Figure 12)
Alternator	Broken, Stretched (Figure 10)
Engine Fire	Broken, Not stretched
Oil Pressure	Broken, Not stretched
Gov Off	Bulb broken, no filament present



Figure 10. Radiograph of the alternator light.

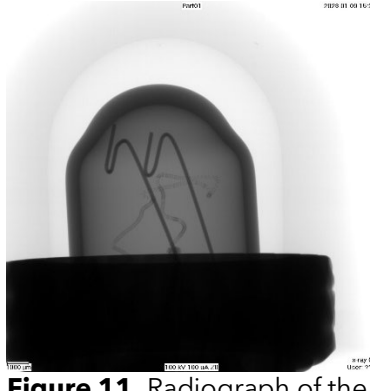


Figure 11. Radiograph of the clutch light.

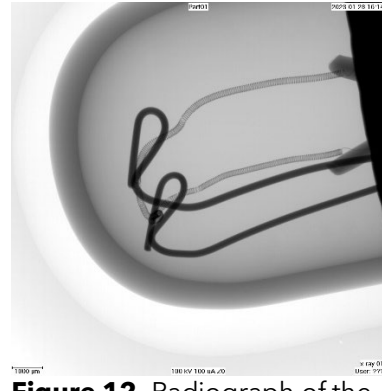


Figure 12. Radiograph of the Low rotor rpm light.

4.0 Robinson Service Letters regarding the use of MS21042L4 nuts

Robinson Helicopters published two service letters addressing the use of certain cadmium plated nuts (MS21042L4 self-locking nuts) that had been found to crack. Service Letter (SL) 38 was issued in 2011 and reminded operators to replace any cracked or corroded nuts. SL-50 was issued in 2014 and instructed operators that “when performing maintenance that involves disassembly of a critical fastener (joints with a secondary lock), the fastener should be reassembled using a D210-series nut.”

The maintenance records did not have documentation that SL-50 had been complied with. Additionally, the wreckage exam determined that a mixture of MS21042L4 and D210-series nuts had been used on flight control hardware throughout the helicopter.

The 2,200-hour overhaul kit that Robinson Helicopter provides includes all new D210-series nuts to replace any MS21042L4 nuts that may have been installed on the helicopter.

Submitted by:

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