

National Transportation Safety Board

Office of Aviation Safety

Washington, DC 20594



ERA24LA166

AIRFRAME AND ENGINE EXAMINATION

N234ZT, R44

A. ACCIDENT DETAILS

Location: Key Biscayne, Florida
Date: April 6, 2024
Time: 1350 EDT
1750 UTC
Aircraft: N234ZT, R44

B. EXAMINATION PARTICIPANTS

Investigator In Charge	Lynn Spencer NTSB/AS-ERA Washington, DC
Powerplants/Piston	John Ellis NTSB/AS-HQ Washington, DC
Group Member	Russell Gait Lycoming Engines Williamsport, PA
Group Member	Ken Martin Robinson Helicopter Torrance, CA
Group Member	Ottoniel Centeno Robinson Helicopter Torrance, CA
Group Member	James Michael Childers Lycoming Engines Williamsport, PA

C. SUMMARY

On April 6, 2024, about 1350 eastern daylight time, a Robinson R-44, N234ZT, was substantially damaged when it was involved in an accident near Key Biscayne, Florida. The pilot was seriously injured. The helicopter was operated as a Title 14 *Code of Federal Regulations* Part 91 personal flight.

The airframe and engine examination took place on May 15-16, 2024, at Florida Air Recovery in Jacksonville, Florida. The above-referenced individuals participated in the examination, which was overseen by the Investigator-in-Charge.

Examination of the airframe and engine revealed no malfunctions that would have prevented normal operation of the helicopter or its engine. Significant saltwater sediment contaminated many hoses and accessories and prevented the determination of pre-impact anomalies that may have affected normal operation.

D. AIRFRAME EXAMINATION

The two-seat R44 Cadet is a single-engine helicopter with a semi-rigid two-bladed main rotor, a two-bladed tail rotor and a skid landing gear. It has an enclosed cabin with side-by-side seating for a pilot and one passenger.

Airframe

At first viewing at the recovery facility, the fuselage and forward empennage remained intact, and the engine remained attached at its mounts. The main rotor blades had been cut at their roots for recovery, the tail exhibited extensive damage, and the aft portion of empennage was impact separated. The tail rotor system and gearbox were not recovered from the ocean.

The windshield was intact, except for a small hole on the right windshield near the front, and the pilot's door window. The mast fairing had minor wrinkling/buckling on its lower edges. There was minor wrinkling/buckling on the rear engine cowling. The vertical firewall exhibited minor wrinkling in the lower right corner. The horizontal firewall did not appear to be damaged. At least three of the main rotor gearbox mounts were intact, but the left forward mount was not visible at the level of airframe disassembly that was conducted.

The tailcone was damaged on both sides in the second bay. It was separated in the fourth bay, where there was distortion on the left side with a shape similar to the shape of the main rotor, and some yellow paint transfer. The sixth bay was detached from the rest of the tailcone. The last bay of the tailcone, as well as the tail rotor gearbox, were not present for the examination, but the empennage was. The upper vertical stabilizer had a large dent on the leading edge near the top, and the shape of the dent was similar to the shape of the main rotor, and there was paint smearing evident in the dent. The horizontal stabilizer, lower vertical stabilizer, and tail skid

'stinger' were intact and did not appear to be damaged. The tail rotor visual guard was fractured at the lower stabilizer.

Flight Control System

The flight control system had discontinuities consistent with overload in the tail rotor push-pull tube in the tailcone. One of the main rotor pitch links had an overload fracture in the lower rod end, and the upper rod end had unscrewed from the pitch link center body, which was not present for the examination. The drive collar for the upper swashplate had overload fractures at the main rotor mast.

No evidence of pre-impact failures of the control system was found. The tail rotor, tail rotor gearbox, and aft section of the C121-17 push pull tube were not present for the examination.

There was red fluid visible in the hydraulic reservoir sight glass.

Force applied to the inputs of the hydraulic servos produced movement of the output piston on all three servos.

The tail rotor pitch change slider was not present, so could not be examined.

Cockpit Controls

The helicopter was equipped with a Garmin GTN 750 GPS/NAV/COM, a Garmin G500H electronic flight instrument display, a Garmin 225 COM, a SAS autopilot and a Garmin ADS-B Out.

Manifold Pressure - 30 in. Hg.

Airspeed Indicator - 130 kts

Altimeter - Partially unreadable due to condensation, 30.0 in. Hg, 250 ft below sea level

Vertical Speed Indicator - 1,500 fpm descent

Carburetor heat - Extended about 2.3 inches, and the down-latch was not engaged. (Carburetor heat valve I air filter housing partially open)

Throttle - Partially open but immovable until the linkage was disconnected at the carburetor.

Mixture - Full rich (The mixture guard was not located in the wreckage.)

Collective Hobbs - 507.30 hours; clutch switch in the "engaged" position.

Ignition - OFF, and no key present

Collective - Mid-travel position; The distance from the top of the collective friction washer to the top of the slider slot was approximately 1.9 inches. This corresponds to a collective position of approximately 35% up from full down.

Circuit breakers - Aux Power, Governor, Horn Start, Clutch Start, Gages, Warning Lights tripped; all others set for operation.

Seats and Seatbelts

Both left and right seatbelts and shoulder harnesses remained attached at all attachment points. The pilot's shoulder harness inertia reel did not lock when quickly pulled.

Powerplant Controls

The mixture control lever on the carburetor was in a full rich position, and the return spring was in place. The mixture control cable housing was secure in the AN735-4 clamps, and the cable housing extended approximately 1/4" from the end of the aft AN735-4 clamp. The control moved freely through full travel.

The carburetor heat control was extended approximately 2.3 inches in the cabin but may have moved with the collective control slightly. The slider valve in the airbox was in a position just under halfway 'on', or 'hot'.

The carburetor heat assist linkage was intact. The carburetor heat assist friction felt normal. The throttle arm on the carburetor was in a position close to full on. The throttle control linkage was intact and moved freely. The overtravel spring compressed and extended normally. The D278-1 governor controller was retained for further examination.

Airframe Fuel System

The airframe fuel shut-off valve was in the ON position. The non-factory locking fuel caps were in place on both the main and auxiliary fuel tanks. All of the fuel lines were intact and in place.

The fuel tank vent lines were intact and in place. Air was able to be blown through both aluminum vent lines in the mast fairing, the tank vent fittings on both tanks, the interconnect hose, and the vent hoses above and below the D251-1 rollover valves.

Air was blown through both rollover valves; however, the balls within the valves did not move when the valves were inverted.

The gascolator was intact and in place. The gascolator was removed and the bowl contained a mixture liquid consistent in color and odor with aviation fuel, some clear liquid that appeared to be water, and a small amount of rust-colored liquid. The drain fitting exhibited rust on its surface. There were no other contaminants visible in the gascolator bowl. The screen was removed and photographed. The screen was replaced, the gascolator was re-assembled, then the fuel tanks were drained into 5-gallon buckets. A total of 10 buckets were filled, containing various mixtures of fuel and water. In all, approximately 22 gallons of fuel and approximately 20 gallons of water were removed from the tanks.

The carburetor float bowl contained murky, rust-colored liquid.

A minimum fuel flow test was conducted by adding about 5 gallons of fuel back into the main tank, and measuring the time required to drain one gallon of fuel into a container. The first several tests resulted in too much time to drain the fuel into the container, including one in which the vent lines were removed. The gascolator screen was removed again, and inspection showed a substantial amount of debris and sediment that had not been present on the first examination. The test was run again with the gascolator screen removed, and the time required to drain one gallon from the fuel line was within the R44 Maintenance Manual allowance of 90 seconds.

Driveline

The drive belts were intact and in place on the upper and lower sheave grooves. The belt tension actuator was intact, and the distance between the anti-rotation scissors was about 1.2 inches.

The upper and the lower actuator bearings rotated freely, and the sprag clutch locked and free-wheeled normally. The forward flex coupling showed no apparent damage. The main rotor gearbox appeared to be undamaged. No oil was visible in the sight glass. The gearbox rotated freely at least one full rotation of the main rotor.

Both elastomeric teeter stops were missing. The droop stops and droop stop tusks were intact and in place. There was very slight scoring, in a short arc pattern, on the main rotor hub just inboard of the pitch change housing for main rotor blade serial number 11208.

Both main rotor blades were intact, but had been saw cut near the roots during wreckage recovery. Main rotor blade serial number 11208 had a slight downward and rearward bend and exhibited compression buckling on the skins in 2 places. There was an area with red paint transfer on the leading edge, running from about 68

to 89 inches from the blade tip. There were a few deep cuts in the lower skin out near the tip on the lower surface.

Main rotor blade serial number 12000 had a slight downward bend. There was a large scratch in the paint on the spar, at approximately 51 inches from the tip.

The intermediate flex coupling was intact but stretched slightly in the axial direction. There was scoring evident on the tailcone bulkhead and tailcone steel frame immediately adjacent to the flex coupling. The tail rotor driveshaft was separated in at least 3 places and the aft portion was not present for the examination, nor was the tail rotor gearbox and tail rotor. The tail rotor driveshaft was separated at the tailcone first bulkhead, and in 2 places near the tailcone separation near the fourth bay. The tail rotor driveshaft damper bearing was free to rotate. The friction linkage was severely bent, but intact, but the friction pivots were not free to move.

Other Systems

There was no emergency locator transmitter (ELT) installed in the helicopter. The landing gear was intact and attached to the airframe. It exhibited no obvious damage, other than some minor damage to the strut fairings.

E. AIRFRAME EXAMINATION PHOTOS



Photo 1 - View of helicopter from the front.



Photo 2 - View of helicopter from the left.



Photo 3 - View of helicopter from the rear.



Photo 4 - View of helicopter from the front right.



Photo 5 - View of the broken windscreen on forward right of cockpit.



Photo 6 - View of damage to front left of fuselage and windscreen.



Photo 7 - Close-up view of tailcone fracture.



Photo 8 - View of fractured empennage.



Photo 9 - Close-up view of main rotor contact on tailboom forward of the empennage.



Photo 10 - View of main rotor mast with rotor blades cut for recovery.



Photo 11 - View of the main rotor blades cut for recovery.



Photo 12 - View of mast fairing interior and deformed control push-pull tubes.



Photo 13 - View of scroll/cooling fan.



Photo 14 - View of main rotor hub and fractured pitch link.



Photo 15 - View of pilot and passenger seats.



Photo 16 - View of cockpit controls and cyclic.



Photo 17 - View of mixture, carburetor heat and circuit breakers.



Photo 18 - View of collective.



Photo 19 - View of manifold pressure gauge.



Photo 20 - View of Collective Hobbs

F. ENGINE EXAMINATION

The helicopter was equipped with a Lycoming O-540-F15B engine, S/N L-27702-40E. As first viewed, the engine remained installed in the rotorcraft and remained cowled. There was little external engine damage. There was impact damage to the rear exhaust when it exited the rear cowl, and to the air filter housing. No baffles blocked the exhaust, and no oil was present in the muffler. The crankcase was intact and undamaged. There was no evidence of contact between the oil cooler or the adjacent cooling sheet metal with the starter ring gear, the alternator cooling fan and drive pulley with the starter ring gear, or the engine cooling fan with the scroll or surrounding hardware. The engine cooling fan scroll inlet rings showed no significant scoring adjacent to the cooling fan 'nose.' There was a short (about 30° of arc) circular score on the aft surface of the upper sheave. The belt tension actuator exhibited no scoring on the surface that is adjacent to the upper sheave. There was continuity from the engine attachment points for the mixture, throttle, and carburetor heat to the cockpit controls. There was no obvious physical damage limiting movement of the throttle.

The cowlings were removed to facilitate the engine exam. While the engine remained installed in the airframe, the carburetor and magnetos were removed. The cooling fan remained secured to the engine's propeller flange. The engine's crankshaft could not be rotated when attempting to rotate the cooling fan by hand. A 2x4 piece of lumber was placed between the fan's fins and with leverage, the crankshaft was rotated approximately 180° before the engine seized again. The engine was removed from the airframe and laid on the forks of a forklift. When the rocker covers were removed, water drained from cylinder Nos. 1, 2, 3, 5, and 6. Oil and a small amount of water drained from cylinder No. 4. The crankcase contained about 2 gallons of water. The oil quick drain was obstructed with sludge and had to be removed to drain the

oil. The remaining oil was sufficient for engine operation. All six cylinders were removed. The No. 5 cylinder was difficult to pull free from the piston, and once freed, a large quantity of blackened salt-like deposit was noted between the cylinder and cylinder wall. Once all the cylinders were removed, the crankshaft rotated freely about its axis and was rotated a full 360° multiple times. Each connecting rod moved freely about its journal on the crankshaft. The camshaft rotated when the crankshaft was rotated, no cracks or fractures were noted, and each cam lobe appeared whole and undamaged. The roller tappets appeared undamaged and moved freely against the lobe of the camshaft as it was rotated by the crankshaft. The crankshaft gear was secured and safe tied and the crank gear dowel pin was not sheared. The idler gears remained in position, appeared undamaged, and rotated when the crankshaft was rotated.

The cylinders had varying amounts of salt deposits and were heavily corroded due to submersion in salt water. Once the valves of each cylinder were released from the binding of the corrosion and deposits, all exhaust and intake valves moved freely in their respective valve guide; no scoring, material transfer, or carbon deposits were noted on the shafts of each valve. Each exhaust valve had its rotator cap installed (this engine does not have rotating intake valves installed). Each pushrod was removed and examined, all pushrods were straight and appeared serviceable. The ball end of each pushrod on the rocker arm side had varying levels of vertical striations, typical of in-service roller tappet engines (Lycoming SA 167A) provides more details about this type of wear. The pistons remained attached to each connecting rod, and no worn piston pin plugs were noted. The faces of each piston and the grooves for the compression and oil control rings were contaminated with salt deposits, and no discrepancies were noted.

The starter remained secured to the engine's crankcase and the power cable remained secured to its post, the starter was not examined further.

The alternator remained secured to the crankcase with the appropriate hardware and brackets and the belt remained in place between the alternator pulley and starter ring gear. The alternator was not examined further.

Fuel System

The carburetor remained secured to the engine's induction plenum and the airframe's air induction system remained secured to the inlet of the carburetor. The airframe induction system showed signs of impact damage. The air filter appeared clean and free of obstructions, and some blue staining was noted on the air filter. The air filter was partially impact crushed. The throttle cable remained secured to the throttle lever with appropriate hardware and the mixture cable remained secured to the mixture lever with appropriate hardware. The throttle was at the full throttle position and the mixture was at the full rich position at the time of the examination.

The carburetor was removed from the engine, disassembled, and examined. The throttle lever was partially seized from corrosion and salt deposits. After actuating the throttle lever several times, it freed up and rotated from the idle stop to the full throttle stop. The mixture lever moved freely and was spring loaded to the full rich position. The carburetor bowl was filled with salt water and sediment, which was poured into a mason jar. The fluid from the carburetor bowl separated with water on top and sediment on the bottom. Salt deposits and corrosion were noted throughout the carburetor due to submersion in salt water. The inlet screen was removed, and some salt deposits were noted on the inlet screen. No additional contamination was noted. Presence of salt water/fuel mixture was noted in the fuel supply line to the carburetor. No engine driven fuel pump was installed.

Ignition System

The left magneto remained secured to the engine's accessory housing with the appropriate hardware and was removed and examined. The drive was seized, and the magneto was disassembled and photo documented. The magneto was filled with salt deposits and was severely corroded from submersion in salt water. During the second day of the exam, was able to break the drive free so it could fully rotate, the points were observed opening and closing as the drive was rotated. The magneto was reassembled, and the points were cleaned. The magneto was rotated with a drill, no spark was noted on any of the ignition towers, likely from the overall condition of the magneto from its submersion in salt water.

The right magneto remained secured to the engine's accessory housing with the appropriate hardware and was removed and examined. The drive was seized and the magneto was disassembled and photo documented. The magneto was filled with salt deposits and was severely corroded from submersion in salt water. During the second day of the exam, was able to break the drive free so it could fully rotate, the points were observed opening and closing as the drive was rotated. The magneto was reassembled, and the points were cleaned. The magneto was rotated with a drill, no spark was noted on any of the ignition towers, likely from the overall condition of the magneto from its submersion in salt water.

All sparkplugs remained secured in their respective positions on each cylinder. The sparkplugs were removed and photo documented. The faces and electrodes of the plugs varied in color and condition due to submersion in salt water.

The ignition harness caps remained secured to their respective magnetos and the leads remained secured to their respective spark plugs. The leads were removed from each plug and the harnesses were cut at the magneto caps. The ignition harness was not examined further.

Oil System

The oil sump was filled with salt water, at the beginning of the exam, the dipstick was removed, and salt water started pouring out of the filler tube. The dipstick was put back in place to prevent water from escaping so the contents could be captured in a container. When the suction screen plug was pulled and the contents drained into a bucket, only a minor amount of oil was present with the salt water. There was a large amount of salt deposits on the bottom of the oil sump, a screwdriver was used to free up the ports that lead to the suction screen plug and the oil contained in the sump was drained into a bucket. The dipstick was reading approximately 11 quarts of oil at the time of examination. The oil suction screen was examined, and some salt deposits and oil sludge noted on the suction screen, no additional contamination was noted. The oil filter remained secured to the oil filter adapter. The oil filter was removed and cut open. The paper element was clean and free of contamination, date and tach time were not recorded on the oil filter body.

G. AIRFRAME EXAMINATION PHOTOS



Photo 21 - Engine before examination.



Photo 22 - Engine removed from airframe.



Photo 23 - View of gascolator bowl, screen and recovered contents.

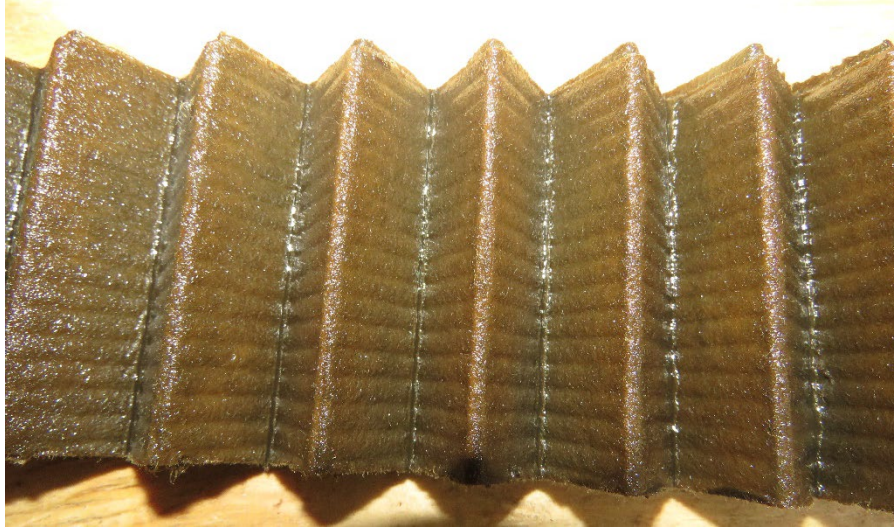


Photo 24 - View of oil filter element.



Photo 25 - View of oil suction screen.

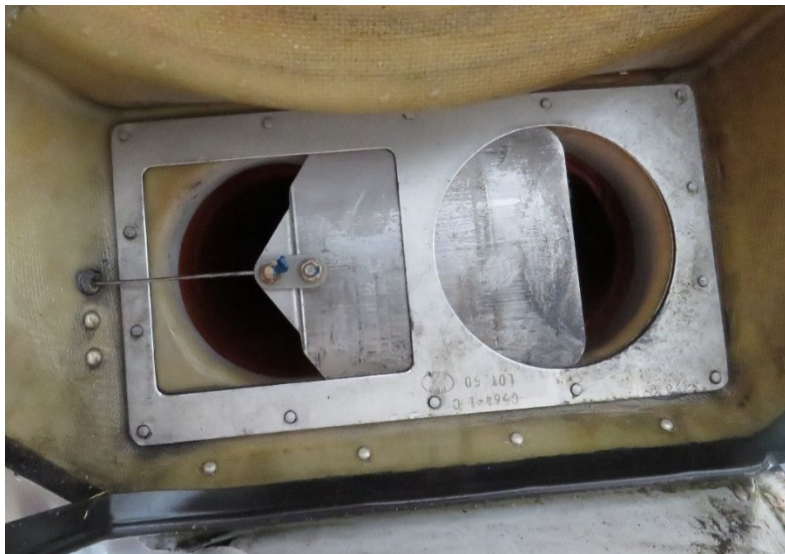


Photo 26: View of carburetor heat valve.



Photo 27 - View of magneto 1 upon removal and disassembly.

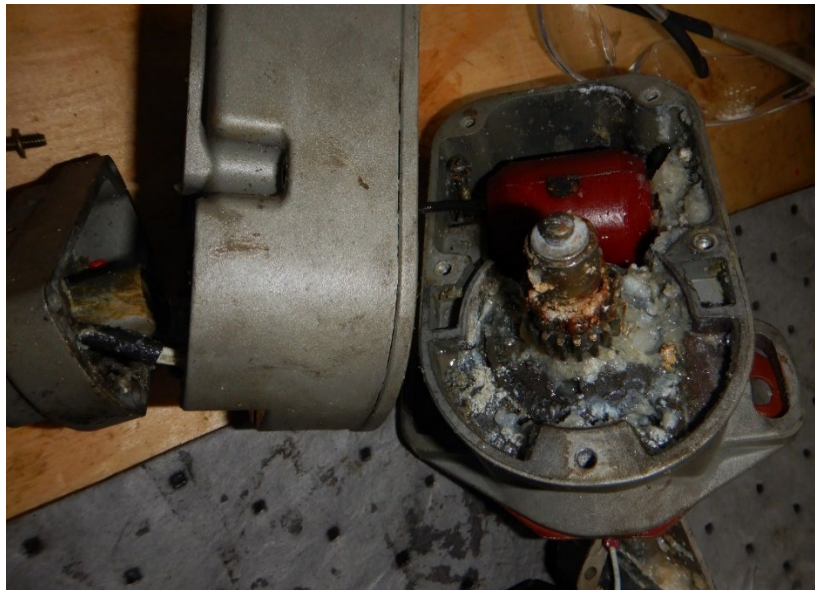


Photo 28 - View of magneto 2 upon removal and disassembly.



Photo 29 - Opened carburetor and drained fluid.



Photo 30 - View of pistons on cylinder Nos. 5, 3 and 1.



Photo 31 - View of pistons of cylinder Nos. 2, 4, and 6.



Photo 32 - View of removed pushrods.



Photo 33 - View of oil sump filled with sludge.



Photo 34 - View of spark plugs.



Photo 35 - View of cylinder No. 1 after removal from engine.



Photo 36 - View of removed valves and springs.



Photo 37 - View of cylinder No. 1 upon removal of valves.



Photo 38 - View of cylinder No. 2 after removal from engine.



Photo 39 - View of removed valves and springs.



Photo 40 - View of cylinder No. 2 with valves removed.



Photo 41 - View of cylinder No. 3 after removal from engine.



Photo 42 - View of removed valves and springs.



Photo 43 - View of cylinder with valves removed.



Photo 44 - View of cylinder No. 4 after removal from engine.



Photo 45 - View of intake valve and spring.



Photo 46 - View of exhaust valve and spring.



Photo 47 - View of cylinder No. 5 after removal from engine



Photo 48 - View of intake valve and spring.



Photo 49 - View of exhaust valve and spring.



Photo 50 - View of cylinder with valves removed.



Photo 51 - View of cylinder No. 6 after removal from engine.



Photo 52 - View of intake and exhaust valves and springs.



Photo 53 - View of cylinder with valves removed.

Submitted by:

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