



MEMORANDUM for RECORD

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Wreckage Examination
Date: July 12-13, 2016
NTSB Accident Number: ERA16FA248 – Hickory, KY

General

The helicopter wreckage was examined at the accident site, Hickory, Kentucky, on July 12, 2016 and at the facilities of AMF Aviation, Springfield, Tennessee on July 13, 2016. The NTSB investigator-in-charge (IIC), the technical advisor (Bell Helicopter) and parties to the investigation (FAA, TVA, and Rolls-Royce) were present.

The helicopter came to rest on its right side, about 220 ft west of the intended landing zone (LZ). The LZ was a level, open, gravel-covered storage area for power transmission equipment. All four main rotor blades separated from the main rotor hub during the impact sequence. The aft section of the tail boom severed from the fuselage, and the tail rotor assembly remained attached to the aft section of the tail boom.

Initial examination of the wreckage revealed that the collective lever, which connected the cockpit collective controls to the main rotor, was disconnected from the pivot sleeve. The attaching hardware for the lever was subsequently found loose in the wreckage near the main rotor hub.

Fuel and Hydraulic Systems

The helicopter's fuel system was not compromised and contained about 695 pounds of fuel. No fuel leaks were observed, and all fuel hoses and lines were secure. The airframe-mounted fuel filter was clean, and the fuel inside was clear with no particulates noted. Hydraulic fluid was observed in the hydraulic system reservoir. All lines and hoses were secure, and there were no leaks noted.

Landing Gear

The right skid of the landing gear was fractured fore and aft, above the saddle. The right step was separated due to fractured brackets. There was an impact mark on the aft portion of the right skid that matched the general size and shape of a ground scar at the point of initial ground impact. The front cross tube remained attached to the fuselage by one bracket, and the rear cross tube was not attached to the fuselage due to fractures at the support brackets.

Fuselage

The plexiglass in the left and right windscreens and chin bubbles was broken, and a majority of the material missing. The plexiglass in the forward, left door was broken and missing. The plexiglass in the forward right door was broken, and a majority of the material was missing. The plexiglass in the right center window was broken with the majority missing. The plexiglass in the aft right door was broken with a majority missing. The left center window was unremarkable. The plexiglass in the aft left door was undamaged.

The forward fuselage exhibited crushing damage on its right side along the bottom of the fuselage. The center post of the windscreen was fractured at the bottom. The battery cover on the nose was damaged near the hinged area near the bottom of the center post. The transmission deck exhibited minor damage to its right side.

Main and Tail Rotor Systems

Examination of the main rotor blades revealed that all four rotor blades were fractured. The yoke exhibited fracturing near all four inner elastomeric shear bearings with "strawing" signatures on the flexures. The blue pitch link was bent outward towards the top with all pitch link hardware present and all cotter keys installed. The red and orange pitch change links were undamaged with pitch link hardware present and all cotter keys installed. The green pitch change link was bent and fractured from impact forces and was found near the main wreckage. Each blade exhibited bending and delamination. All blades exhibited ground impact marks on the leading edges.

Main rotor continuity was confirmed by rotating the drive shaft by hand. Movement was confirmed from the drive shaft through the transmission to the mast. The transmission was visually inspected and no pre-impact anomalies were observed. The chip detectors were removed and visually inspected with no ferrous particulate matter observed. No abnormal sounds were heard when the transmission was rotated by hand. The transmission was not disassembled.

The tail boom was fractured near the aft bulkhead, just aft of the intercostal support and the fracture surfaces were consistent with a counter-clockwise main rotor strike to the ground. The vertical fin displayed scraping damage on its lower, outboard side, and the anti-collision light remained intact. The tailskid remained attached. Both the left and right finlets on the horizontal stabilizer were fractured and missing from the stabilizer from impact forces.

Both tail rotor blades exhibited minor ground impact damage; however, no rotational scoring was observed on either blade. The tail rotor was easily rotated in both directions with no

abnormal binding or noises. The pitch of the tail rotor blades was manipulated by hand with appropriate control movement noted forward to the aft end of the fractured control tube. The flapping stops exhibited compression signatures with corresponding impact marks on the yoke.

The forward end of the forward short shaft remained attached to the output end of the freewheel unit. The aft end of the forward short shaft remained attached to the forward end of the oil cooler blower shaft. The oil cooler blower shaft was rotated by hand with slight binding due to shifting of the forward end of the aft short shaft. The forward end of the aft short shaft remained coupled with the aft end of the oil cooler blower shaft. The aft end of the aft short shaft remained connected to the hanger bearing. Rotational scoring was observed on the aft short shaft with signatures indicative of contact with the engine oil tank bracket. The forward end of the #4 tail rotor drive shaft segment was separated. The #3 and #2 tail rotor drive shaft segments were separated from the tail boom and were found adjacent to the main wreckage. The forward end of the #1 tail rotor drive shaft segment was connected to the hanger bearing with the aft end of the #1 tail rotor drive shaft segment connected to the input shaft of the tail rotor gear box at the Thomas coupling. Oil was evident in the tail rotor gear box. No chips were observed on the gear box chip detector.

Flight Controls

The left collective control was not installed. Collective control continuity was confirmed through the right collective and up through the servo actuators to the disconnected collective lever. The two collective lever pivot pins and screws that attached the collective lever to the pivot sleeve were not installed. The pivot pins and screws were found on the transmission deck and on the ground underneath the right side of the helicopter. The flat washers and safety wire were missing; the washers were later found during a subsequent examination of the wreckage.

The left cyclic control was not installed. Cyclic control continuity was confirmed through the right cyclic and up through the servo actuators to the inner, non-rotating swashplate.

The left anti-torque pedals were intentionally locked in place by the operator before the accident flight. The right anti-torque pedals were fractured at the outboard bell crank of the pedal control tube; however, directional control was confirmed when the tail rotor control tube, located near the tail rotor servo, was manipulated by hand. During manipulation, there was corresponding movement of the fractured pedal control tube and the fractured control tube aft of the tail rotor servo.

Engine

The engine remained in place, and all mounts were secure. No external engine damage was noted during the inspection. The hydromechanical unit linkage was intact, and its rigging appeared normal. The helicopter was equipped with an engine inlet barrier filter, which was normal in appearance and did not appear to be obstructed.

The engine-mounted fuel filter bowl from the combined engine filter assembly (CEFA) was full of clean, normal-appearing fuel. The CEFA fuel filter element was free of debris, and the

pending bypass button was not extended. The fuel nozzle exhibited no anomalies, and some carbon formation was noted on the air shroud.

The engine-mounted scavenge oil filter on the CEFA was free of debris, and the pending bypass indicator button was not extended. The oil reservoir, which was mounted on the helicopter, was compromised, which precluded determination of the oil level. Both the upper and lower magnetic chip detectors were free of ferrous particulate matter. The engine gearbox oil was not drained.

No foreign object damage was noted on the compressor inlet guide vanes or on the impeller blade leading edges. The N1 rotor turned with some resistance and was mechanically coupled from the compressor to the starter generator. The N2 system turned when manipulated by hand and was continuous to the main rotor head. Due to deformation of the exhaust stack, the fourth-stage turbine wheel could not be inspected.

All of the external air, oil, electrical, and fuel lines were secure when checked by hand. None of the b-nut connectors were loose, and torque paint was present on the connections. No red indicators were visible on the electrical connectors.

The engine was controlled by a full authority digital electronic control (FADEC), which contained non-volatile memory in the electronic control unit (ECU). By design, when one of the predetermined parameter trip points is exceeded, the ECU begins recording incident data at a rate of one record per 1.2 seconds. The initial trigger for this event was low rotor speed (less than 92%).

The ECU was downloaded by a Rolls-Royce technical representative. A review of the data revealed no engine anomalies that would have precluded the engine from performing to specification before impact.

The ECU also retained engine maintenance history data in the maintenance terminal section. There were no pre-event faults or abnormalities noted in the maintenance terminal data. There were multiple faults recorded during the event, which corresponded to the impact sequence.