



NATIONAL TRANSPORTATION SAFETY BOARD

Office of Aviation Safety

Western Pacific Region

January 30, 2018

AIRFRAME & ENGINE EXAMINATION

WPR17LA188

Eldorado Hills, California

August 25, 2017

1900 PDT

Robinson R-44; N61NM

Attendees:

Stephen Stein
Air Safety Investigator (IIC)
National Transportation Safety Board
Federal Way, Washington

Richard Dilbeck
FAA Aviation Safety Inspector
Federal Aviation Administration
Sacramento, California

Thom Webster
Technical Investigator
Robinson Helicopter Company
Torrance, California

HISTORY OF FLIGHT

On August 25, 2017, about 1900 Pacific daylight time, a Robinson R-44 Raven II, N61NM, was substantially damaged when it encountered a dynamic rollover during a forced landing attempt in Eldorado Hills, California. The commercial pilot and his passenger received minor injuries. The helicopter was registered to A M Helicopter Services, LLC and operated by a private individual as a personal flight, which was conducted under the provision of *14 Code of Federal Regulations Part 91*. Visual meteorological conditions prevailed and a flight plan was not filed for the local flight that departed Auburn Municipal Airport (AUN), Auburn, CA at 1830.

According to the accident pilot, the helicopter had recently been returned by a flight school in Utah who had leased the helicopter for about 2 years. The helicopter owner invited the pilot to fly the helicopter, but did not indicate that the helicopter had any problems. Prior to departure, the pilot completed a preflight inspection and then started the helicopter flew. He performed two magneto tests; one at 75% engine power and the other at 100% engine power. Although the pilot

did not observe any anomalies, he did not recall if he waited until the needle stabilized before reading the measurements. the helicopter once in the airport traffic pattern and then taxied to the fuel isle. After adding 20 gallons of 100 low lead aviation grade gasoline, the pilot and his passenger departed on the accident flight. They flew around a soccer field so the passenger could take photographs and then flew to a nearby lake where they completed an autorotation. During the end of the maneuver, as they approached the ground both the pilot and passenger heard the low rotor rpm horn, which was accompanied by its corresponding annunciator light. The rotor rpm increased after the pilot added power. They subsequently flew to a friend's house and approached the property from the north. The pilot decelerated and transitioned into an in-ground effect hover over his friend's backyard, but the downwash started to blow debris into the pool. Although his friend was signaling the pilot to land on a concrete block adjacent to the pool, the pilot elected to find another landing zone. He backed the helicopter up over a solar panel array at a lower terrain elevation, but the main rotor rpm started to decay and the low rotor rpm horn engaged. The pilot applied full power, which increased the manifold pressure to 28 in Hg and placed the rotor rpm at approximately 96%; however, the helicopter started to descend, so the pilot dropped the collective, which returned the rotor rpm to the normal range. He then completed a pedal turn and rotated the helicopter about 360° to look for a more suitable landing site, but the helicopter started sinking again. The pilot informed his passenger that he was going to set the helicopter down on the solar panel array. As the left skid impacted a solar panel, the passenger exited the left side of the helicopter and ran to the east. Almost simultaneously, the helicopter ascended about 20 feet and then began to sink again, but as it descended the helicopter followed the passenger to a grass area. The helicopter's right skid impacted the grass followed by the left skid and the helicopter completed a dynamic rollover onto its left side.

In the passenger's statement, which corroborated the pilot's remarks, he reported that he did not hear an engine or rotor harmonic during the dynamic rollover.

A postaccident examination of the helicopter by the Federal Aviation Administration and NTSB revealed substantial damage to main rotor blades and cockpit. Mechanical continuity was confirmed from the cyclic to the swash plate, the collective to the main rotor blades, and from the rudder to the tail rotor.

PERSONNEL INFORMATION

The pilot, age 60, held a flight instructor certificate with ratings for rotorcraft and instrument helicopter. He held an additional certificate as an airframe and powerplant mechanic and additional ratings as a flight instructor for airplane single-engine land and multi-engine land. The pilot's most recent second-class medical certificate was issued on April 17, 2017, which included one limitation: "must wear corrective lenses."

According to the pilot, he had accumulated a total of 3,985 total flight hours and 66.5 hours in the helicopter make and model. The pilot estimated that he flew about 3 total hours in the helicopter make and model within the 90 days that preceded the accident. He further estimated that he amassed about 500 total flight hours in Robinson R-22s, but did not accrue any flight experience in the R-22 in the last 90 days.

AIRCRAFT INFORMATION

According to Federal Aviation Administration (FAA) records, the helicopter was manufactured in 2006 and registered to A M Helicopter Services on May 20, 2008. The airplane was powered by a Lycoming IO-540-AE1A5, a direct drive, air cooled, 260 hp engine. A review of the logbooks revealed that the helicopter's most recent annual and 100 hour airframe inspections was completed on May 21, 2017 at an accumulated time of 1,991.3 flight hours.

The engine received its most recent 100 hour inspection on May 21, 2017 at 1,991.3 total flight hours, which was performed by IA maintenance, a service facility in Woods Cross, Utah. In this entry, the mechanic recorded that he performed a differential compression check, cleaned, gapped, and tested the spark plugs, inspected the magneto and tachometer points and checked engine to magneto timing. With the exception of the hobbs times, the previous 100 hour inspection record, dated January 1, 2017, was identical to the May 2017 entry including the compression values.

The owner leased the accident helicopter to a flight school for 2 years beginning in 2015 for flight instruction to generate income before the tail and main rotor blades reached their maximum calendar life limit. It was subsequently returned to the owner on August 21, 2017 at which time the pilot reported to the owner that the helicopter was "underpowered." According to the accident pilot, the ferry pilot's description of the helicopter's performance was not communicated to him when the owner invited him to fly the helicopter after it arrived.

METEOROLOGICAL INFORMATION

The recorded weather was captured from a weather station at Auburn Municipal Airport (AUN), Auburn, California, located approximately 13.5 nm north of the accident site.

The 1855 recorded weather observation at AUN included winds from 250° magnetic, visibility 10 statute miles, clear skies, temperature 32° C, dew point 26° C, and an altimeter setting of 29.86 inches of mercury.

WITNESS REPORTS

According to the property owner, the passenger of the accident helicopter contacted him to ask if they could land on his property. About 4 minutes after the owner gave them permission to land, he heard the helicopter approaching his backyard from the north. During this time he observed single puffs of smoke coming from the helicopter every 3-4 seconds. The property owner went outside to receive them and directly the helicopter to land on a concrete slab next to the pool, but there appeared to be some confusion as he then observed the helicopter enter a hover over some foliage behind his pool. Photographs show the owner's pool directly behind the house and solar panel array about 30 feet below the pool; the solar panels and pool are separated by foliage. The helicopter then turned 90° to the east while sliding to the left accompanied by more smoke. After the helicopter ascended over the solar panels it entered a pedal turn as it started to descend. The helicopter then turned west and north before it disappeared from the witness' view.

Approximately 15 seconds later the helicopter “popped” back up into the witness’ view momentarily and turned southeast, now with a constant stream of smoke coming from the aircraft. The stream ceased for a second and then continued. The helicopter settled back down out of the witness’ view over the solar array and seconds later he heard it impact branches and then the ground. He recounted that the smoke color was a very dark gray color that never changed, but the engine sounded smooth and continuous throughout the accident sequence.

AIRFRAME

Airframe Examination

Flight Controls

Cyclic control movement was confirmed from the cyclic to the main rotor blades and collective control was verified from the collective to the main rotor blades. Collective control was confirmed from the cockpit to the swash plate. All three main rotor servos operated smoothly when the cyclic and collective were actuated by hand with no indication of excessive leaking. Rudder pedal continuity was confirmed from the cockpit to the tail rotor. The rudder pedals were smooth. The rod end to one of the main rotor pitch change links was broken, consistent with overload separation.

Drive System

The main rotor blades had been removed by the recovery team; however, the main rotor hub movement was continuous to the tail rotor blades, which were still attached to the tail rotor hub. Both the main rotor and tail rotors rotated smoothly and oil was present. The V belts were in good condition and in place on the sheaves. Continuity from the upper sheave to the main rotor blades through the main rotor drive shaft and from the upper sheave to the tail rotor blades.

Airframe and Tailcone Damage

Scuff marks were observed on both the nose and belly of the helicopter. Longitudinal scoring was observed on both the chin and helicopter belly. The left windshield was shattered. The left side of the roof and left door frames sustained impact damage along with the forward edge of the main fuel tank. No visual damage was observed to lower structural tubing. A small dent was observed in tailcone bay no. 4 on the left side and another small dent on the upper surface of tailcone bay no. 5 forward of the strobe light. The strobe light lens was shattered and the left side navigation antenna was damaged. Leading edge damage to upper vertical stabilizer and mid-span. Trailing edge damage was observed on the horizontal stabilizer. The tail skid was bent upward with core scoring on the lower surface and the tail rotor guard was broken at the stabilizer. Photographs taken at the accident site show the tail skid in its original position and the tail rotor guard unbroken.

Main Rotor and Tail Rotor Blades

Main rotor blade, serial number 2217C, displayed upward bowing near the tip, chordwise creasing throughout the blade span, and is bent opposite the direction of rotation. Tree residue was observed on the leading edge.

Main rotor blade, serial number 2224C, displayed upward bowing and was bent opposite the direction of rotation. Chordwise creasing was observed throughout the span of the blade. A 5 foot section of afterbody was separated from the blade spar about mid-span. Tree residue was observed on leading edge from lower surface.

Tail rotor blade, serial number 2667I, displayed multiple dents near leading edge on the outboard skin and coarse scuff marks on the trailing edge. Tree residue on both inboard and outboard skins.

Tail rotor blade, serial number 2665G, exhibited tree residue on both inboard and outboard skins.

Cockpit

The aft wall of the right seat structure was damaged. The air conditioning vent was distorted. Powerplant controls functioned properly with the exception of the mixture control, which was not adjusted properly, but could still be moved throughout its full range. None of the circuit breakers were popped with the exception of the avionics fan.

Fuel System

No reports or indication of fuel leaks from either the main tank or auxiliary fuel tank. Both fuel caps were secure and the vent tubes were clear. The gascolator screen displayed trace amounts of debris and the fuel exhibited an odor and color consistent with 100 low lead aviation grade gasoline.

The key was turned to the prime position to test the auxiliary fuel pump, which did not engage during the attempt.

Landing Gear

The rear crosstube was bowed.

Engine Examination

The ignition harness leads were removed from the spark plugs, most of the leads showed indications of arcing. The ignition lead wires to the cylinder no. 3 and 5 spark plugs were loose and the rim of the upper plug to cylinder no. 1 displayed corrosion. Both the lower and upper spark plugs were manufactured by Champion Aerospace, part number REM38E, and removed and placed in a spark plug tray. Each plug displayed excessive contamination, which consisted of pliable carbon deposits and other debris that caused electrode bridging. When compared to the Champion Aerospace Aviation Service Manual, the plugs were similar to the manual's classification of "severely fouled" plugs. The bottom spark plugs to cylinder nos. 1, 3, and 5

displayed oil fouling, consistent with the helicopter's resting position on its side at the accident site. The engine was rotated by hand using the cooling fan, which showed light compression on all six cylinders. The oil fouled spark plugs were cleaned of oil residue using a spray solvent. A magneto synchronizer was used to measure the magneto timing, which revealed a timing of 10° before top dead center (the manufacturer's specification is 20° before top dead center).

The spark plugs were re-installed, a quart of piston engine oil was added and the helicopter was moved to an open area for an engine run. Initially, the engine was started normally and idled at 64% for about 2 minutes until the oil temperature was in the green range. During this time the engine ran rough and excessive gray smoke streamed from the tailpipe. After the warm-up was complete, the rpm was increased to 100% and the engine continued to run rough. The rpm was then reduced to 75% and a magneto check was completed; the rpm level dropped to 61% on the left magneto and to 55% on the right magneto.

After the engine run, when comparing cylinder temperatures by hand, the temperature of cylinder no. 5 was cooler than the other cylinders. Additionally, the cylinder no. 3 intake pipe was loose. The lower spark plugs were then removed and a compression test was performed at 80 psi. The results are captured in Table 1 below. During each cylinder compression test, air could be heard leaking from the exhaust.

Cylinder Number	Pressure Measurement
1	28 psi
2	34 psi
3	52 psi
4	38 psi
5	36 psi
6	54 psi

Table 1: Compression Test After Engine Run

Each spark plug was then cleaned using a sand blaster. A visual inspection of the electrodes after cleaning revealed varying gaps and excessively worn electrodes on some of the plugs. The spark plugs were re-installed and the engine a second engine ground was performed with similar results as the first test.

The valve covers were then removed and the rocker arms were inspected, which did not reveal any anomalies.

Valve Measurement

After the airplane wreckage was released, the accident pilot reported that he observed only trace movement from the intake valves for cylinder nos. 5 and 6, which are actuated by the same camlobe at the camshaft. The NTSB IIC subsequently examined the intake valve movement with the accident pilot at his hangar. Initially, the pilot used the started to crank the engine, while the NTSB IIC observed the intake valves, which confirmed that both intake valves for cylinder nos. 5 and 6 did extended about one third the distance of the other intake valves. A dial indicator was

then setup to approximate camlobe lift by measuring the lift from the intake valve. The dial indicator measured 0.112 inches for the cylinder no. 6 intake valve lift when at its highest point. The dial indicator was then placed above the cylinder no. 6 exhaust valve, which measured 0.398 inches of lift at the valve's highest point.

Camlobes

The engine was removed from the airplane and the cylinders were examined to inspect the camlobe that supports the intake valves to both cylinder nos. 5 and 6. Both intake and exhaust cylinder push rods for each cylinder, stamped part no 15F19957-57, were about equal in length.

The cam lobe to the intake valves for cylinder nos. 5 and 6 was severely worn and spalled (see photographs 2 & 3).



Photograph 1 – Spark Plugs



Photograph 2 – Intake Camlobe from Cylinder no. 5



Photograph 3 – Intake Valve Camlobe from Cylinder no. 6



Photograph 4 – Exhaust Valve Camlobe from Cylinder no. 5