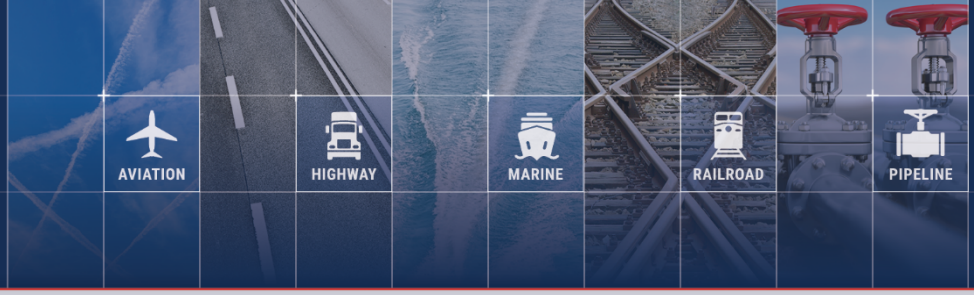

Aviation Investigation Factual Report

Location:	Ronan, Montana	**Accident Number:**	WPR17LA143
Date & Time:	July 6, 2017, 16:45 Local	**Registration:**	N442DR
Aircraft:	ROBINSON HELICOPTER COMPANY R44 II	**Aircraft Damage:**	Substantial
Defining Event:	Loss of tail rotor effectiveness	**Injuries:**	1 Serious, 1 Minor
Flight Conducted Under:	Part 91: General aviation - Personal		

On July 6, 2017, about 1645 mountain daylight time, a Robinson R-44 II helicopter, N442DR, was substantially damaged during an emergency landing in Ronan, Montana. The private pilot was seriously injured and the passenger received minor injuries. The helicopter was registered to a private individual and operated by the pilot as a Title 14 *Code of Federal Regulations* Part 91 personal flight. Visual meteorological conditions prevailed and no flight plan was filed for the local flight which originated from Ronan Airport (7S0), Ronan, Montana about 1600.

The pilot reported that he had planned to provide a family member, his passenger, with a scenic tour of the area. About 45 minutes into the flight at an approximate altitude of 300 ft above ground level (agl), and an airspeed of about 35 kts, the pilot suddenly experienced an uncommanded yaw which he perceived as a loss of tail rotor authority, as the helicopter began to turn clockwise. The helicopter started spinning slowly at about one revolution every five seconds and the use of the anti-torque pedals did not stop the rotations. The pilot continued to attempt to counteract the rotation with left pedal, which he maintained for the rest of the flight. Additionally, he lowered the collective control and reduced throttle to idle power. He subsequently pulled the collective control at an approximate altitude of about 5 ft agl for landing, but the helicopter impacted the ground hard, which resulted in substantial damage to the tailcone and tail rotor. According to his recount, the pilot did not observe any aural or visual warning indications, nor did he experience any vibrations. The engine continued to run normally after the helicopter came to rest. The pilot further added that the winds were calm at the time of the accident. The accident site elevation was 3,090 ft.

According to an eyewitness who was 1/4 mile from the accident site, the helicopter was about 150 ft agl flying north when it turned west, flew over them and made a full left 360° turn. As the helicopter returned to a northern heading, he heard the engine "rev" once and then observed the helicopter make two full 360° rotations before it descended behind the tree line. The engine harmonic sounded continuous and uninterrupted with the exception of the "rev" moment. The witness heard the helicopter impact terrain and the engine continue to run. The witness proceeded to the accident site, and drained about 10 gallons of fuel that was leaking from the helicopter.

In their written statements, which were documented separately, both the pilot and passenger stated that the helicopter rotated clockwise. During a subsequent conversation, the passenger also remarked that they had turned to observe a black-haired cow, which they had mistaken for a black bear. He was focused on the animal when the uncommanded yaw began. The passenger further remarked that the helicopter continued to rotate clockwise about 90° after it impacted the ground.

Postaccident examination by a Federal Aviation Administration (FAA) aviation safety inspector revealed multiple dents and protrusions throughout the tailboom that appear to have originated from within the tailboom section. Additionally, scorched vegetation was present at the location of the engine exhaust.

Pilot Information

Certificate:	Private	**Age:**	68,Male
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	Unknown
Instrument Rating(s):	None	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	No
Medical Certification:	Class 3 With waivers/limitations	**Last FAA Medical Exam:**	May 25, 2017
Occupational Pilot:	No	**Last Flight Review or Equivalent:**	November 23, 2015
Flight Time:	1033 hours (Total, all aircraft), 936.2 hours (Total, this make and model), 835 hours (Pilot In Command, all aircraft), 0 hours (Last 90 days, all aircraft), 0 hours (Last 30 days, all aircraft), 0 hours (Last 24 hours, all aircraft)		

The pilot, age 68, held a private pilot certificate with ratings for airplane single-engine land and rotorcraft. His most recent third-class medical certificate was issued on May 25, 2017, with one limitation, "glasses available for near vision." According to his personal logbook records, which were current as of April 29, 2017, the pilot accumulated a total of 1,033 total flight hours and 936 hours in the helicopter make and model. Most of the pilot's fixed-wing flight time was accrued in a Cirrus SR-22 airplane and some of his helicopter flight experience was accrued in the accident helicopter. The pilot's most recent flight review was completed on November 23, 2015.

Aircraft and Owner/Operator Information

Aircraft Make:	ROBINSON HELICOPTER COMPANY	**Registration:**	N442DR
Model/Series:	R44 II II	**Aircraft Category:**	Helicopter
Year of Manufacture:	2004	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	10428
Landing Gear Type:	N/A; Ski	**Seats:**	4
Date/Type of Last Inspection:	August 2, 2016 Annual	**Certified Max Gross Wt.:**	2500 lbs
Time Since Last Inspection:	7 Hrs	**Engines:**	1 Reciprocating
Airframe Total Time:	246.8 Hrs at time of accident	**Engine Manufacturer:**	LYCOMING
ELT:	C91 installed, not activated	**Engine Model/Series:**	IO-540-AE1A-5
Registered Owner:	On file	**Rated Power:**	205 Horsepower
Operator:	On file	**Operating Certificate(s) Held:**	None

The helicopter was manufactured in 2004 and registered to Trilock USA, Inc. on July 15, 2004. The helicopter was powered by a Lycoming IO-540-AE1A5, 260 hp engine. A review of the logbooks revealed that the helicopter's most recent annual airframe and engine inspections were completed on August 1, 2016 at an accumulated flight time of 240 total flight hours. At the time of the accident, the helicopter had accrued 246.8 hours total time in service.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	MSO,3234 ft msl	**Distance from Accident Site:**	4 Nautical Miles
Observation Time:	16:53 Local	**Direction from Accident Site:**	310°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	/ None	**Turbulence Type Forecast/Actual:**	/ None
Wind Direction:		**Turbulence Severity Forecast/Actual:**	/ N/A
Altimeter Setting:	30.12 inches Hg	**Temperature/Dew Point:**	37°C / 5°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Ronan, MT (7S0)	**Type of Flight Plan Filed:**	None
Destination:	Ronan, MT (7S0)	**Type of Clearance:**	Unknown
Departure Time:	16:00 Local	**Type of Airspace:**	Unknown

The recorded weather was captured from a weather station at Missoula International Airport (MSO), Missoula, Montana, located approximately 33 nm south of the accident site. The MSO site elevation was 3,200 ft.

The 1653 recorded weather observation at MSO included calm winds, visibility 10 statute miles, clear skies, temperature 37°C, dew point 05°C, and an altimeter setting of 30.12 inches of mercury.

Additional observations were collected by a Remote Automatic Weather Station (RAWS) observation about 3.5 nm northwest of the accident site, and an approximate 30 foot higher elevation than the accident site.

According to the 1631 RAWS recorded weather observation, the temperature was 35°C the sustained wind was from 050° at 3 kts, gusting to 6 kts. The wind direction changed to a direction of 270° about 1 hour later.

Wreckage and Impact Information

Crew Injuries:	1 Serious	**Aircraft Damage:**	Substantial
Passenger Injuries:	1 Minor	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Serious, 1 Minor	**Latitude, Longitude:**	47.476387,-114.055274(est)

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. Both anti-torque pedals were seized in the forward position; however, continuity was traced from the anti-torque pedals to the forward portion of the C121-17 push/pull tube. An overload separation of the -17 push/pull tube was observed at the no. 3 bulkhead in the tailcone. Movement of the push/pull tube was verified from the no. 3 bulkhead to the tail rotor blades through the tail rotor gearbox. The examination did not discover any foreign object damage or any obstructions to the movement of the flight controls.

Drive System

The main rotor drive shaft was continuous from the aft end of the clutch shaft through the transmission to the main rotor. The tail rotor drive shaft was continuous from the aft end of the clutch shaft through the tail rotor gearbox to the tail rotor. Both the main rotor and tail rotors rotated smoothly and oil was present with the tail rotor gearbox. Both V-belts were intact and did not display any abnormal wear. The upper sheave V-belts remained in their respective grooves and the lower sheave V-belts had advanced one groove.

Tailcone

Bays no. 1 and 2 were impact damaged and bay nos. 4, 5, and 6 displayed multiple dents and protrusions from within the inside diameter of the tailcone. Multiple dents were observed on the lower left side of the tailcone accompanied by a white paint transfer mark consistent with tail rotor blade contact. The damper bearing hangar bracket separated into pieces, which allowed the bearing to rotate inside the tail cone and fracture the -17 push/pull tube and damage the inside diameter of the tail cone. Rotational scoring was observed throughout the inside diameter of the tailcone cavity. The no. 3 bulkhead was damaged and the 6, 7 bulkhead were both fragmented and deformed. The tailcone strobe light had separated from its housing.

Tail Rotor Drive Shaft

The tail rotor drive shaft exhibited two notable bends in the forward section and one bow in the aft section. The intermediate flex plate displayed rub marks adjacent to the yokes. Both the intermediate and aft flex couplings were straight. The damper bearing support was fractured and the bearing had

shifted on the shaft about 1/10 in. The damper bearing rotated freely.

Tests and Research

The damper bearing assembly was submitted to the NTSB material's laboratory for further examination. The assembly included the damper bearing, lower and upper angled support brackets, transverse support bracket pieces, bulkhead pieces, and a section of the tail rotor drive shaft. Additionally, an Adel clamp with a piece of insulated wire, and corresponding bulkhead pieces were also submitted to the laboratory for material analysis.

Postaccident photographs showed the damper bearing was attached to the drive shaft, but was fractured from its support bracket assembly at the no. 3 bulkhead. The drive shaft was intact, but bent, and insulated wires were wrapped around the shaft aft of the no. 6 bulkhead. The pitch control tube (located at the bottom of the tailboom) was fractured just aft of the no. 3 bulkhead and bent aft of the no. 5 bulkhead.

The tail rotor drive shaft had an "S" shaped bend mostly near the forward half of the shaft length, and the pitch control tube was fractured at a location corresponding to the position of the damper bearing. The tube forward of the fracture was crushed and had transverse sliding contact marks within 1 inch of the fracture.

As assembled, the damper bearing is attached to a lower angled support bracket that is attached to an upper angled support bracket to form a jackknife type support. The upper end of the upper angled support bracket is attached to the center of a transverse support bracket, and the ends of the transverse support bracket are attached to the aft side of the no. 3 bulkhead. The transverse support bracket was fractured in several locations, and the lower support bracket was fractured in two locations. Functionality of the damper internal drive assembly was confirmed when it was rotated by hand.

The transverse support bracket, and upper and lower vertical angled brackets' fracture surfaces were all consistent with ductile overstress fracture. No evidence of fatigue crack growth was observed.

Complete reports of the airframe examination and the materials laboratory examination are available in the NTSB public docket.

Additional Information

According to the helicopter manufacturer, "during low speed maneuvering, a pilot can lose awareness of the helicopter power setting. If collective pitch is increased excessively, the power required by the main rotor exceeds the full-throttle power available, causing rotor rpm to decrease. Since tail rotor rpm is tied

to main rotor rpm, the tail rotor speed also decreases. Although the engine is still providing maximum torque to the main rotor, the tail rotor is unable to provide adequate counter-torque since the thrust is greatly reduced due to the low rpm. This is effectively loss of tail rotor effectiveness (LTE), but loss of effectiveness due to low rpm is not typically considered when referring to LTE."

Safety Notice SN-34, entitled, "Aerial Survey and Photo Flights – Very High Risk" was released in 1999, and revised in April 2009. The pilot's operating handbook includes SN-34, which states that while maneuvering, an inexperienced pilot who slows the helicopter to less than 30 knots to maneuver for the best viewing angle may lose track of airspeed and wind conditions. During this time the helicopter may lose translational lift and begin to settle. The pilot may raise the collective to stop the descent, which can reduce RPM and power available, resulting in a higher descent rate. Because tail rotor thrust is proportional to the square of rpm, if the rpm drops below 80% nearly one-half of the tail rotor thrust is lost and the helicopter will rotate nose right. The resulting decrease in rpm can cause the main rotor to stall and the helicopter to descend rapidly while continuing to rotate.

Conversely, rapidly lowering the collective control will engage the throttle correlator and close the throttle, thereby quickly reducing power.

To remediate this condition, the manufacturer suggested rolling the throttle wide full open before lowering the collective, which will allow the engine and rotor rpm to return to 102%.

Low Rotor RPM and Caution Light

According to the pilot's operating handbook (POH), a horn and an illuminated caution light indicate that rotor rpm may be below safe limits. To restore rpm the handbook states that the pilot should immediately roll the throttle on, lower collective and, in forward flight, apply aft cyclic. The horn and caution light are disabled when collective is full down.

Loss of Tail Rotor Thrust in Forward Flight

The emergency procedures section of the POH contains instructions for responding to a loss of tail rotor thrust. According to the excerpt, the first step requires the pilot to enter an autorotation. The procedure then requires the pilot to main 70 knots airspeed and then roll throttle to the OFF position past the overtravel spring.

Administrative Information

Investigator In Charge (IIC):	Stein, Stephen
Additional Participating Persons:	Cliff Carpenter; Federal Aviation Administration; Helena, MT Thom Webster; Robinson Helicopter Company; Torrance, CA
Report Date:	January 15, 2020
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB did not travel to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=95520