Aviation Investigation Final Report

Location:	Wenatchee, Washington	**Accident Number:**	WPR13FA243
Date & Time:	May 25, 2013, 17:45 Local	**Registration:**	N99090
Aircraft:	Hiller UH-12E	**Aircraft Damage:**	Substantial
Defining Event:	Powerplant sys/comp malf/fail	**Injuries:**	1 Minor, 1 None
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The pilot reported that, after takeoff, when he was 3 miles from the airport, he heard a noise above and behind him. The pilot immediately turned the helicopter back toward the airport; when about 1 mile away, he heard a second noise. The pilot continued to the airport and was hovering the helicopter about 4 feet above the ground when the main rotor head and blades separated from the helicopter, flew up into the air, and impacted the ground about 300 feet away. The helicopter impacted the ground hard, and the tailboom separated about midspan.

Postaccident examination revealed that the main transmission housing exhibited multiple fractures on its second stage planetary gear housing; the fractures were primarily orientated vertically and were through the thin-walled section of the housing. Analysis of these fracture surfaces revealed that the cracks were consistent with overstress from radial stresses. The transmission was disassembled and substantial damage was observed to the first stage planetary gear teeth and the input gear teeth. A high quantity of metallic chips and flakes were discovered at the bottom of the lower housing and throughout the first stage planetary assembly. All six bolts securing the bevel gear to the first stage planetary carrier were fractured. Only one of the six separated bolt heads remained secured with safety wiring. The six bolts were removed each bolt exhibited fatigue fracture features consistent with overstress, such as crack arrest and beach marks, that surrounded a center region. The fatigue cracks initiated along the thread roots of the bolts; these cracks were generally positioned about 180 degrees from each other, and were consistent with failure from reverse bending fatigue. After the bolts fractured, the bevel gear was unconstrained, leading to overstress fracture of the adjacent components. The fracture surface of the main rotor shaft was analyzed; the fracture surface was orientated 45 degrees from the longitudinal direction of the shaft, and the shaft was deformed to one side. All features were consistent with overstress failure in tension.

A complete set of maintenance records were not available for review, thus, it could not be determined if the bolts met installation requirements or if regular inspection of bolt tightness was met.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:

Fatigue failure of the six bolts that secured the bevel gear to the first stage planetary carrier, which caused the transmission to seize while the helicopter and main rotor were still operating.

Findings

Aircraft	(general) - Fatigue/wear/corrosion
Aircraft	(general) - Fatigue/wear/corrosion
Aircraft	(general) - Not specified

Factual Information

History of Flight

Enroute-cruise	Powerplant sys/comp malf/fail (Defining event)
Maneuvering-hover	Part(s) separation from AC
Maneuvering-hover	Off-field or emergency landing

On May 25, 2013, about 1745 Pacific daylight time, a Hiller UH-12E, N99090, landed hard after the main rotor head assembly separated from the helicopter at Pangborn Memorial Airport (EAT), Wenatchee, Washington. The commercial pilot was not injured, and the passenger sustained minor injuries. The helicopter sustained substantial damage throughout. The helicopter was registered to and operated by the pilot under the provisions of 14 Code of Federal Regulations Part 91. No flight plan was filed for the personal flight. Visual meteorological conditions prevailed for the flight that originated from EAT at about 1730 hours.

The pilot reported that after takeoff, when he was about three miles away from the airport, he heard a noise above and behind him. The pilot immediately turned the helicopter back towards the airport; when about one mile away, he heard a second noise. The pilot continued to the airport and hovered about four feet above the ground; the main rotor head and blades separated from the helicopter and flew up into the air. Subsequently, the helicopter impacted the ground hard and the tailboom separated about mid span. Shortly thereafter, the main rotor head and blades impacted the ground about 300 feet away.

Pilot Information

Certificate:	Commercial; Flight instructor	**Age:**	61
Airplane Rating(s):	Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	Helicopter	**Toxicology Performed:**	No
Medical Certification:	Class 2 With waivers/limitations	**Last FAA Medical Exam:**	July 6, 2012
Occupational Pilot:	UNK	**Last Flight Review or Equivalent:**	July 6, 2011
Flight Time:	1555 hours (Total, all aircraft), 928 hours (Total, this make and model), 1286 hours (Pilot In Command, all aircraft), 2 hours (Last 90 days, all aircraft), 1 hours (Last 30 days, all aircraft), 1 hours (Last 24 hours, all aircraft)		

The pilot, age 61, held a commercial pilot certificate for single- and multi-engine land airplane, helicopter, and a certified flight instructor certificate for helicopter issued June 10, 2012. The pilot also held an airplane instrument rating. On July 6, 2012, he was issued a second-class airman medical certificate with the limitation that he must wear corrective lenses, and possess glasses for near and intermediate vision. The pilot reported that at the time of the accident he

had about 1,555 total hours, 928 of which were in the accident helicopter make and model.

Aircraft and Owner/Operator Information

Aircraft Make:	Hiller	**Registration:**	N99090
Model/Series:	UH-12E	**Aircraft Category:**	Helicopter
Year of Manufacture:	1962	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	1395
Landing Gear Type:	High skid	**Seats:**	3
Date/Type of Last Inspection:	November 1, 2012 100 hour	**Certified Max Gross Wt.:**	2750 lbs
Time Since Last Inspection:		**Engines:**	1 Reciprocating
Airframe Total Time:	10568 Hrs as of last inspection	**Engine Manufacturer:**	LYCOMING
ELT:	Installed, not activated	**Engine Model/Series:**	VO-540 SERIES
Registered Owner:	HOLMES JEFF	**Rated Power:**	310 Horsepower
Operator:	HOLMES JEFF	**Operating Certificate(s) Held:**	None

The three seat, high skid helicopter, serial number 1395, was manufactured in 1962. It was powered by a Lycoming VO-540-C2A 305-horsepower engine. The helicopter's most recent maintenance inspection was a 100 hour inspection that occurred on November 1, 2012 at an airframe total time of 10,568.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	EAT,1249 ft msl	**Distance from Accident Site:**	0 Nautical Miles
Observation Time:	17:55 Local	**Direction from Accident Site:**	
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	Broken / 10000 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	5 knots /	**Turbulence Type Forecast/Actual:**	/ None
Wind Direction:	80°	**Turbulence Severity Forecast/Actual:**	/ N/A
Altimeter Setting:	29.93 inches Hg	**Temperature/Dew Point:**	18°C / 3°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Wenatchee, WA (EAT)	**Type of Flight Plan Filed:**	None
Destination:	Wenatchee, WA (EAT)	**Type of Clearance:**	None
Departure Time:	17:42 Local	**Type of Airspace:**	

At 1755, weather at EAT was reported as wind from 080 degrees at 5 knots, visibility of 10 statute miles, broken clouds at 10,000 feet above ground level, temperature 18 degrees C, dewpoint 3 degrees C, and an altimeter setting of 29.93"Hg.

Airport Information

Airport:	Pangborn Memorial Airport EAT	**Runway Surface Type:**	Asphalt
Airport Elevation:	1249 ft msl	**Runway Surface Condition:**	Dry
Runway Used:		**IFR Approach:**	None
Runway Length/Width:		**VFR Approach/Landing:**	Precautionary landing

The Pangborn Memorial Airport (EAT) is a non-towered airport about four miles east of Wenatchee, Washington. The airport features two asphalt runways at a reported elevation of 1,249 feet. One runway is 5,700 feet long, 150 feet wide, and orientated on 120 and 300 degrees respectfully; the other runway is 4,460 feet long, 75 feet wide, and orientated on 070 and 250 degrees respectfully.

Wreckage and Impact Information

Crew Injuries:	1 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	1 Minor	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Minor, 1 None	**Latitude, Longitude:**	47.392223,-120.203613(est)

Due to the nature of the accident, the NTSB did not conduct an on scene investigation. However, it was reported by airport management that the helicopter's main fuselage was mostly intact and sustained minimal damage. The landing skids exhibited no apparent deformation. The tailboom was fracture separated about midspan, however, the tail rotor drive shaft was still connected along the entire length. The main rotor hub and blades separated from the main rotor shaft and came to rest about 300 feet away from the fuselage.

Tests and Research

Postaccident Examination

The main transmission remained attached to the helicopter. The main transmission housing exhibited multiple fractures on its center (second stage planetary gear) housing; the fractures were primarily orientated vertically, and were through the thin walled section of the housing. The main rotor shaft and tail rotor drive shaft were still connected to the transmission. After disconnecting the tail rotor drive shaft from the main transmission, investigators attempted to rotate the main rotor shaft by hand; however, it would not turn clockwise or counterclockwise. The main rotor shaft fracture surface was removed from the main rotor shaft for further examination.

The tail rotor drive assembly was removed from the main transmission lower housing; metallic chips and flakes were observed in the residual oil and on the gear teeth. One of the pieces appeared to have heat discoloration. The main transmission was removed from the helicopter for further examination.

Transmission Teardown

The transmission was removed and examined at the facilities of Hiller Aircraft Corporation. The transmission was disassembled; substantial damage was observed to the first stage planetary (epicyclic) gear teeth and the input gear teeth. A high quantity of metallic chips and flakes were discovered at the bottom of the lower housing and throughout the first stage planetary assembly. All six bolts securing the bevel gear to the first stage planetary carrier were fractured. Only one of the six separated bolt heads remained secured with safety wiring; the remaining five bolt heads were not found. Inspection of the oil supply lines and nozzles found no evidence of blockages, and the transmission's internal components

above the first stage planetary assembly showed no signs of oil starvation. The center housing, bevel gear, fractured bevel gear bolt, and the fracture surface of the main rotor shaft were retained for metallurgical examination at the NTSB materials laboratory.

NTSB Materials Laboratory

The NTSB materials lab removed and cleaned the six bolts from the bevel gear. All of the bolt fracture surfaces exhibited comparable features. Each bolt exhibited fatigue fracture features, such as crack arrest and beach marks that surrounded a center region consistent with overstress. The fatigue cracks initiated along the thread roots of the bolts; these cracks were generally positioned about 180 degrees from each other, and were consistent with failure from reverse bending fatigue.

The transmission center housing was examined and contained three longitudinal cracks, each of which was present across a bolt hole in the flange. The three cracks progressed through most of the housing cross section to the opposite flange. Two of the cracks were backcut, and the crack faces were analyzed. The crack faces exhibited features consistent with overstress fracture from radial stresses (hoop stresses); there were no indications of corrosion or progressive failure modes.

The portion of main rotor shaft that was previously sectioned about two inches from the fracture surface was analyzed. The fracture surface of the shaft was orientated 45 degrees from the longitudinal direction of the shaft, and was generally dark and exhibited a rough texture. The shaft had also been deformed to one side; all of these features were consistent with overstress failure in tension.

Administrative Information

Investigator In Charge (IIC):	Link, Samantha
Additional Participating Persons:	David Hartson; Federal Aviation Administration; Spokane, WA Steve Palm; Hiller Aircraft Corporation; Firebaugh, CA
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