



National Transportation Safety Board Aviation Accident Final Report

Location:	Kalispell, MT	Accident Number:	SEA07FA014
Date & Time:	11/02/2006, 2055 MST	Registration:	N407KH
Aircraft:	Bell 407	Aircraft Damage:	Substantial
Defining Event:		Injuries:	3 None
Flight Conducted Under:	Part 91: General Aviation - Positioning - Air Medical (Medical Emergency)		

Analysis

While conducting EMS operations the helicopter sustained substantial damage after a loss of engine power, autorotation, and forced landing. The pilot reported hearing a loud bang, followed by the engine spooling down. The helicopter collided with a chain link fence during the forced landing sequence. Postaccident inspection of the engine revealed an uncontained second stage turbine wheel burst (on-speed) as a result of oil starvation and subsequent bearing failure. During the onsite examination, fresh oil residue was noted along the right side of the helicopter's fuselage, tail boom assembly and leading edges of the tail rotor blades. Oil wetting and staining was also observed on the concrete hangar apron, and a trail of fresh oil extended from apron to the helipad where the helicopter departed. Additionally, onsite investigators noted that the oil pressure transducer line coupling B-nut (near the foreword bulkhead) was found two flats loose, and four complete rotations from complete separation. Evidence of oil loss, sooting and localized fire damage was observed in the area of the fitting union. The accident flight was the helicopter's first flight following the completion of a maintenance action item in the general area of the aforementioned fitting. Following the maintenance action, an engine run (ground) and post run inspection was completed by a line pilot. No discrepancies were noted and the helicopter was returned to service. The mechanic who performed the maintenance action was not present during the post run inspection.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: On-speed failure of the second stage turbine wheel as the result of engine oil starvation. The lack of maintenance oversight was a contributing factor.

Findings

Occurrence #1: LOSS OF ENGINE POWER

Phase of Operation: CLIMB

Findings

1. (C) TURBINE ASSEMBLY, TURBINE WHEEL - BURST
2. (F) FLUID, OIL - STARVATION
3. (F) MAINTENANCE, INSPECTION - INADEQUATE - COMPANY MAINTENANCE PERSONNEL
4. TURBINE ASSEMBLY, SHAFT BEARING - FAILURE

Occurrence #2: FORCED LANDING

Phase of Operation: EMERGENCY DESCENT/LANDING

Occurrence #3: IN FLIGHT COLLISION WITH OBJECT

Phase of Operation: LANDING

Findings

5. OBJECT - FENCE

Factual Information

HISTORY OF FLIGHT

On November 2, 2006, at 2055 mountain standard time, a Bell 407 helicopter, N407KH, sustained substantial damage during a forced landing, subsequent to a loss of engine power (uncontained failure), shortly after departure from the Kalispell Regional Medical Center, Kalispell, Montana. The helicopter was operated as a visual flight rules (VFR) emergency medical services (EMS) positioning flight under Title 14, CFR Part 91. Of the three occupants aboard, the certificated commercial helicopter pilot and two medical crewmembers were not injured. The helicopter was owned and operated by Kalispell Regional Medical Center, Kalispell, Montana. Dark night visual meteorological conditions prevailed, and company VFR flight following procedures were in effect. The flight originated about 2051 from the hospital's helipad, and was en route to Bigfork, Montana (approximately 12 miles east-southeast). The helicopter sustained substantial damage to the tail boom assembly during the landing sequence.

During a telephone conversation with the National Transportation Safety Board investigator-in-charge (November 2), and in a subsequent written statement, the pilot of the accident helicopter reported that approximately 1 minute after takeoff (during the initial climb) from the hospital's helipad, the flight paramedic, who was seated in the left front seat, informed him (the pilot) that the "ENG [engine] CHIP" light on the caution light panel had just illuminated. The pilot stated that after confirming the caution light "I immediately flipped my goggles [the pilot was wearing night vision goggles- NVG's] up and turned the helicopter around and headed back to hospital because it was the closest available pad and it was illuminated." The pilot stated that the engine started making "weird growling noises" and began to "surge" as he turned a 1/4-mile final for the helipad. The pilot reported that the growling noise and surging was followed by a loud "bang" which emanated from the rear of the helicopter. The pilot stated that he lowered the collective and entered an autorotation.

The helicopter touched down at the perimeter of the intended helipad and collided with a chain link fence. The helicopter slid approximately 25 feet before coming to rest. The pilot completed an emergency "shutdown," and he and the two crewmembers exited the helicopter without injuries. After exiting the helicopter, the pilot and staff from the hospital's emergency department (ED) extinguished a small fire in the helicopters engine bay.

The purpose of the flight was to pick-up a medical patient in Bigfork and return to the departure hospital.

SURVIVAL ASPECTS

The pilot, seated in the right front seat, the flight paramedic, seated in the left front seat and the flight nurse, seated in the right rear forward facing seat, were not injured.

PERSONNEL INFORMATION

The pilot-in-command held a commercial pilot certificate with airplane single-engine land, helicopter-rotorcraft and helicopter instrument ratings.

The pilot's most recent FAA second-class medical certificate was issued on October 10, 2006. The medical certificate carried no limitations or waivers.

According to the Pilot/Operator accident report (Form 6120.1/2), completed by the operator, the pilot's total time was 3,000 hours; 2,430 hours (PIC) rotorcraft and 500 hours total PIC time in Bell 407's.

The report indicated that the pilot had flown 43 hours in the 90-day period preceding the accident, of which 31 hours were in a Bell 407.

The pilot completed a 5-day factory ground and flight training course for the Bell 407 at the Bell Helicopter Training Academy in August of 2006.

On March 31, 2006, the pilot completed initial training and testing requirements prescribed by FAR 135.293 and 135.295.

The pilot began his employment as a pilot with Kalispell Regional Medical Center in March of 2006.

HELICOPTER INFORMATION

The helicopter, a Bell 407, serial number 53395, was manufactured in 1999. The single-engine helicopter was powered by a Rolls-Royce model 250-C47B turbo shaft engine (serial number CAE 847433). The helicopter was configured and equipped for EMS operations.

The helicopter was maintained in accordance with an Approved Airworthiness Inspection Program (AAIP) on a continuous basis. The helicopter's last inspection, a phase 3 inspection, in accordance with the AAIP, was completed on September 15, 2006. The helicopter's total time at inspection was 3,138 hours. At the time of the accident, the helicopter's total time was 3,213.9 hours.

According to the operator, the helicopter was removed from service on the day of the accident to facilitate the completion of Bell Helicopter Technical Bulletin (TB) 407-05-63 "Rotor Brake Modification Kit 407-704-022-101, Installation Of." The TB outlines the procedures and parameters for replacement/modification of the rotor brake assembly. According to the manufacture, installation of the brake modification kit will minimize wear associated with vibration. The Hobbs time at the completion of the maintenance action was 3,213.8.

At the completion of the aforementioned maintenance actions, an engine run (ground) was completed. A post run-up inspection, completed by the pilot, noted no discrepancies or anomalies. Night visual meteorological conditions prevailed at the time of the engine run. The mechanic who performed the maintenance was not present during the run-up or subsequent post run inspection. The engine cowlings were not opened during the post run inspection. At the completion of the maintenance run, the helicopter was moved to a hangar where the post maintenance run inspection was completed and then returned to service.

The maintenance action began about 1100 and was completed about 1830 local.

There were no open logbook maintenance discrepancies concerning the helicopter at the time of the accident.

METEOROLOGICAL INFORMATION

The closest weather observation recourse to the accident site was an Automated Surface Observing System (ASOS) located at Glacier Park International Airport (KGPI), 6 nautical miles northeast of the accident location at an elevation of 2,977 feet above mean sea level (msl). The 2053 METAR (Aviation Routine Weather Report) observation was, in part, prevailing

visibility 2 statute miles in mist and light snow, overcast skies at 1,700 feet, temperature -2 degrees C, dew point -3 degrees C.

WRECKAGE AND IMPACT INFORMATION

Representatives from the Helena, Montana, Flight Standards District Office (FSDO), Bell Helicopter and Rolls-Royce conducted the initial on scene portion of the investigation, which commenced on November 3, and reported the following finding:

The fuselage was intact and minimal damage was noted to the main and aft cabin. Damage was noted to the tail rotor driveshaft, driveshaft housing and horizontal stabilizer. A section of the tail rotor drive shaft was located on the roof of the hospital approximately 225 feet from the point of touchdown. All four main rotor blades were intact, however, impact related damage (near the blade tips) was observed to the leading edges of the main rotor blades. The tail rotor gearbox and associated tail rotor blades were intact.

Fresh oil residue was noted along the right side of the helicopter's fuselage below the engine bay. The oil residue was more prominent near the forward section of the engine bay. Fresh oil residue was also noted along the tail boom assembly and on the leading edges of the tail rotor blades. The onsite investigative team also reported that oil wetting and staining was observed on the concrete hangar apron, and a trail of fresh oil extended from apron to the helipad where the helicopter departed. Oil was also noted on the hangar door and several locations around the pad.

Extensive tearing type damage was noted to the upper engine cowling. The damage was concentrated at the 9 to 11'oclock and 1 to 3'oclock (when viewed from the aft of the engine looking forward), and in the same plane of rotation as the 2nd stage turbine wheel. Three oil lines (the return line to the oil cooler, and two bearing scavenge lines on the starboard side of the engine) were severed. The damaged oil lines were in the same plane of rotation as the 2nd stage turbine wheel. Extensive tearing and puncture type deformation, from the inside out, was noted to the turbine case and associated containment ring. The case (gas producer support) was torn open, in the same plane of rotation as the 2nd stage turbine wheel (just aft [along the gas path] of the energy absorption ring), and segments of the fractured 2nd stage turbine wheel were visible. Both compressor discharge tubes (right and left) also sustained extensive puncture and tearing type damage along the same plane of rotation as the 2nd stage turbine wheel.

The oil pressure transducer line coupling B nut was found loose. Investigators reported the B nut, which is located on the aft right side of the forward engine firewall, was found "two flats" loose, and was four complete rotations from separating from the fitting. Evidence of oil loss, sooting and localized fire damage was observed in the area of the fitting union.

With battery power supplied, the measured gas temperature indicator (MGT) exhibited an "E" on the gauge representing an expedience; the gas producer tachometer (Ng) indicator and the engine torques meter indicator (TRQ) both read zero. A download of the instruments was unsuccessful. All other gauges displayed static conditions.

Following the removal of the engine from the airframe, both magnetic chip detectors were removed; the lower chip detector was clean and the upper chip detector contained a large amount of metallic slivers and chips. The gearbox oil was drained during the process, and contained approximately 360 milliliters of oil.

Two segments of the second stage turbine wheel, a 7-bladed segment and a 3-bladed segment, were located on the ground along the helicopter's final approach flight path. The first wheel segment contained the remains of approximately 7 airfoil blades; the second segment contained the remains of approximately 3 airfoil blades.

An additional 8-bladed segment of the second stage turbine wheel was later found on the roof of the hospital near the location of the accident.

TESTS AND RESEARCH

The engine was examined and disassembled on November 28-29, 2006, at the facilities of Rolls-Royce, Indianapolis, Indiana. Representatives from NTSB, FAA, Rolls-Royce, Standard Aero and Kalispell Regional Medical Center were in attendance. The following observations were noted during the examination and disassembly.

Compressor Section: The compressor case, compressor rotor assembly, forward compressor support and diffuser scroll were intact and no damage was noted. The compressor inlet was clear and no evidence of foreign object damage (FOD) was observed. Heat distress and coked oil deposits were noted to the aft portion of the spur adapter gear shaft. No evidence of excessive wear or deformation to the spur adapter was noted. Heat distress, and a lack of residual oil, was observed on the number 2 bearing.

Accessory Gearbox: The accessory gearbox was intact and no damage was noted to the assembly. All internal components were functional and no evidence of excessive wear or deformation was noted.

Turbine Section: In addition to the aforementioned damage, disassembly revealed rub type damage on the trailing edge of the inner web area and outer rim section of the remaining segments of the second stage turbine wheel. Rub type damage was noted to the leading edge airfoils of the second stage nozzle assembly and trailing edge of the inner seal of the energy absorption ring. The first stage turbine wheel assembly remained intact, however, impact type damage was noted to the first stage turbine wheel airfoils. Rub type damage was noted to the trailing edge rim face and inner Curvic teeth. Minimal damage was noted to the first stage nozzle assembly. Damage was noted to the third stage turbine wheel assembly. The outer portions of the airfoils were fractured and missing. Molten debris and splatter, which was later identified as remnants of the turbine splined adapter and end of the turbine to compressor coupling, was observed in the bore area of the wheel.

Bearings: Extensive damage was noted to a number of the bearing assemblies. Extensive deformation, smearing, metal splatter, and thermal discoloration were noted to the number eight bearing assembly. Extensive wear was noted to the individual ball bearings and associated ball separators. A number of the individual ball bearings were separated from the cage and were later located when the engine was dissembled. The number eight oil supply strut, which supplies oil to the bearing, was flowed with oil and no anomalies were noted. Representatives from Rolls-Royce reported that the damage to the bearing assembly "was consistent with damage generated while operating the engine with insufficient lubrication." Similar damage was noted to the six and seven bearing assemblies.

Combustion Section: The combustion assembly was intact and no damage was noted.

The engine's electronic control unit (ECU) data was downloaded by Rolls-Royce. The stored data showed that prior to record 10, no faults were recorded, and the engine was in a

continuous operational condition. The power turbine (Np [N2]) and main rotor (Nr) were approximately 100 percent through record 10, and the gas generator speed (Ng [N1]) was approximately 76 percent. Subsequent to record 10, the plotted data shows a rapid deterioration in engine speed. The fuel flow, gas generator, torque and associated parameters immediately begin to drop in conjunction with the rapid loss of power turbine speed.

The Incident recorder (IR) function in the ECU operates by monitoring predetermined engine parameters and records conditions that are determined to be abnormal. If an anomaly is detected, the data associated with the anomaly is written to the systems non-volatile memory that can later be downloaded and interpreted.

Subsequent to the engine examination and disassembly, personnel from Rolls-Royce reported the damage was consistent with an on-speed burst of the second stage turbine wheel. Following the engine examination and subsequent laboratory testing, Rolls-Royce issued a report outlining the findings pertaining to the fractured turbine wheel. The report, dated March 3, 2007, stated, "Rub damage and thermal distress from friction heating on the forward side of the Second Stage Turbine Wheel resulted in an on-speed burst" of the wheel assembly. The report also stated that the "composition, hardness and microstructure of the Second Stage Turbine Wheel away from the rub damage areas were as required by the engineering drawings."

ORGANIZATIONAL INFORMATION

At the time of the accident, Kalispell Regional Medical Center held an air carrier certificate issued in May of 1980, by the Federal Aviation Administration (FAA). The company's operations specifications included authorization to conduct helicopter air ambulance operations in accordance with 14 CFR Part 135. The certificate was managed by the FAA Flight Standards District Office (FSDO) in Helena, Montana.

When the accident occurred, Kalispell Regional Medical Center employed five pilots, one mechanic, and operated one helicopter. The mechanic was full-time status and also served as the operator's Director of Maintenance (DOM).

ADDITIONAL INFORMATION

The DOM reported that the referenced B-nut fitting was not manipulated during the maintenance procedure involving the rotor brake modification. He also reported that he did not perform a leak check following the maintenance action and engine run.

The helicopter was released to the operator on December 18, 2006.

Pilot Information

Certificate:	Commercial; Military	Age:	39, Male
Airplane Rating(s):	Single-engine Land	Seat Occupied:	Right
Other Aircraft Rating(s):	Helicopter	Restraint Used:	Seatbelt, Shoulder harness
Instrument Rating(s):	Helicopter	Second Pilot Present:	No
Instructor Rating(s):		Toxicology Performed:	No
Medical Certification:	Class 2 Without Waivers/Limitations	Last Medical Exam:	10/01/2006
Occupational Pilot:		Last Flight Review or Equivalent:	05/01/2006
Flight Time:	3000 hours (Total, all aircraft), 593 hours (Total, this make and model), 2500 hours (Pilot In Command, all aircraft), 43 hours (Last 90 days, all aircraft), 14 hours (Last 30 days, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Manufacturer:	Bell	Registration:	N407KH
Model/Series:	407	Aircraft Category:	Helicopter
Year of Manufacture:		Amateur Built:	No
Airworthiness Certificate:	Normal	Serial Number:	53395
Landing Gear Type:	High Skid	Seats:	5
Date/Type of Last Inspection:	09/01/2006, AAIP	Certified Max Gross Wt.:	5250 lbs
Time Since Last Inspection:	68 Hours	Engines:	1 Turbo Shaft
Airframe Total Time:	3138 Hours	Engine Manufacturer:	Rolls-Royce
ELT:	Installed, not activated	Engine Model/Series:	250 C47
Registered Owner:	Kalispell Regional Medical Center	Rated Power:	674 hp
Operator:	Kalispell Regional Medical Center	Air Carrier Operating Certificate:	On-demand Air Taxi (135)

Meteorological Information and Flight Plan

Observation Facility, Elevation:	KGPI, 2977 ft msl	Observation Time:	2055 MST
Distance from Accident Site:	6 Nautical Miles	Condition of Light:	Night/Dark
Direction from Accident Site:	20°	Conditions at Accident Site:	Visual Conditions
Lowest Cloud Condition:		Temperature/Dew Point:	-2° C / -3° C
Lowest Ceiling:	Overcast / 1700 ft agl	Visibility	2 Miles
Wind Speed/Gusts, Direction:		Visibility (RVR):	
Altimeter Setting:	29.95 inches Hg	Visibility (RVV):	
Precipitation and Obscuration:	Light - Showers - Snow		
Departure Point:	KALISPELL, MT (MT28)	Type of Flight Plan Filed:	Company VFR
Destination:	Kalispell, MT	Type of Clearance:	None
Departure Time:	2051 HST	Type of Airspace:	

Airport Information

Airport:	KALISPELL REGIONAL HOSPITAL (MT28)	Runway Surface Type:	Concrete; Grass/turf; Gravel
Airport Elevation:	2970 ft	Runway Surface Condition:	Dry; Snow
Runway Used:	H	IFR Approach:	None
Runway Length/Width:		VFR Approach/Landing:	Forced Landing; Straight-in

Wreckage and Impact Information

Crew Injuries:	3 None	Aircraft Damage:	Substantial
Passenger Injuries:	N/A	Aircraft Fire:	In-Flight
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	3 None		

Administrative Information

Investigator In Charge (IIC): Dennis J Hogenson **Adopted Date:** 11/29/2007

Additional Participating Persons: Rickey E Koffman; FAA FSDO; Helena, MT
Doug Tate; FAA FSDO; Indianapolis, IN
Mark Stuntzner; Bell Helicopter; Fort Worth, TX
Jeff Edwards; Rolls-Royce; Indianapolis, IN
John Swift; Rolls-Royce; Indianapolis, IN
Doug Roberge; Standard Aero; Winnipeg, MB, Canada,
Jim Dicks; Kalispell Region Medical; Kalispell, MT

Publish Date:

Investigation Docket: NTSB accident and incident dockets serve as permanent archival information for the NTSB's investigations. Dockets released prior to June 1, 2009 are publicly available from the NTSB's Record Management Division at pubinq@ntsb.gov, or at 800-877-6799. Dockets released after this date are available at <http://dms.nts.gov/pubdms/>.

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