Aviation Investigation Final Report

Location:	Dove Creek, Colorado	**Accident Number:**	CEN13FA415
Date & Time:	July 16, 2013, 09:55 Local	**Registration:**	N775AR
Aircraft:	Bell UH-1H	**Aircraft Damage:**	Substantial
Defining Event:	Loss of control in flight	**Injuries:**	1 Fatal
Flight Conducted Under:	Part 133: Rotorcraft ext. load		

Analysis

The helicopter pilot flew inbound to a seismic survey location hoisting a basket load with a long-line rope. The pilot overshot the intended drop site, and the basket load and long-line impacted the ground after the pilot likely initiated a load release. The helicopter then entered a right bank, followed by a steep left bank, and subsequently impacted the ground.

Postaccident examination of the helicopter revealed evidence consistent with a loss of hydraulic fluid from the flight control system due to a hydraulic leak of a check valve fitting near the tail rotor servo. As the pilot approached the survey location, the loss of hydraulic pressure most likely resulted in very-high collective control forces and pilot-induced oscillations. The director of maintenance stated that the pilot and a mechanic were aware of the hydraulic fluid leak and had ordered replacement parts; however, they had not yet been installed. He stated that they did not expect the leak to cause a significant issue. Thus, it is likely that they did not foresee the leak causing a significant flight hazard.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: Pilot-induced oscillations caused by the loss of hydraulic assist of the flight controls due to an excessive loss of hydraulic fluid during a critical phase of flight, which resulted in ground impact. Contributing to the accident was an inadequate analysis of the hydraulic fluid leak by the pilot and mechanic.

Findings

Aircraft	Lateral/bank control - Attain/maintain not possible
Aircraft	Hydraulic fluid - Incorrect service/maintenance
Personnel issues	Understanding/comprehension - Pilot
Personnel issues	Understanding/comprehension - Ground crew

Factual Information

History of Flight

Maneuvering-hover	Collision with terr/obj (non-CFIT)
Maneuvering-hover	Loss of control in flight (Defining event)

HISTORY OF FLIGHT

On July 16, 2013, about 0955 mountain daylight time, a Tamarack UH-1H helicopter, N775AR, was substantially damaged after a loss of control and ground impact near Dove Creek, Colorado. The pilot, the sole occupant, was fatally injured. The helicopter was registered to BVDS Incorporated and operated by Billings Flying Service under the provisions of 14 Code of Federal Regulations Part 133 during a seismic survey operation. Visual meteorological conditions prevailed for the local flight, which departed without a flight plan from a staging area near Dove Creek, Colorado, about 0953.

According to ground witnesses at the survey location, the pilot flew inbound to their location from the left seat, hoisting a basket load with a long line rope. The pilot overshot the intended drop site and the basket load impacted the ground, followed immediately by the 150 foot long line falling straight down onto the basket load. At about the same time, the helicopter entered into a right bank, followed by a left bank. The helicopter subsequently impacted the ground in a steep left bank.

PERSONNEL INFORMATION

The pilot, age 27, held a commercial pilot certificate with airplane single and multiengine land, airplane instrument, and rotorcraft-helicopter ratings. The pilot also held a flight instructor certificate, with airplane single and multi-engine and rotorcraft-helicopter ratings, as well as a mechanic airframe and power plant certificate. On June 24, 2013, the pilot was issued a Class 2 medical certificate, with no restrictions. A review of the pilot's flight records indicated that he had logged over 5,000 hours total flight time, with over 1,800 hours in the make and model of the accident helicopter. During the seven days prior to the accident, the pilot had flown the accident helicopter about 15 flight hours.

AIRCRAFT INFORMATION

The accident helicopter, originally manufactured in 1965 by Bell Helicopter, Inc., was equipped with a Lycoming T53-L-13B engine, composite main rotor blades and BLR Aerodynamic Solutions Tailboom Strakes and Fast Fin System. The Federal Aviation Administration (FAA) certified the helicopter to be flown from the left seat and issued a restricted type certificate (TC) to Tamarack Helicopters, Inc., which authorized agricultural, forest/wildlife, and external load operations.

Following extensive maintenance and refurbishment by Billings Flying Service, the helicopter was released for maintenance test flights on June 5, 2013. At the time of the accident, the helicopter had flown a total of 14,798 hours, which included 41 flight hours after completion of the refurbishment.

The helicopter was operating about 700 pounds (lbs.) below performance limit capability for a 50 foot out of ground (OGE) hover as the pilot approached the survey location. The basic helicopter weight, as documented in the Form B aircraft weighing record, was 5,240 lbs. Total helicopter weight was about 8,000 lbs., based on an estimated 2,000 lbs. basket load, 500 lbs. fuel load, 180 lbs. pilot weight, and 80 lbs. of miscellaneous tools/personal gear. As calculated with the FAA-approved operator manual supplement hover chart, the maximum weight for a 50 foot OGE hover was about 8,700 lbs.

METEOROLOGICAL INFORMATION

The weather observation station at Cortez Municipal Airport (KCEZ), Cortez, Colorado, located about 21 miles to the south of the accident site, reported the following conditions at 0953: wind 300 degrees at 4 knots, visibility 10 miles, overcast clouds at 8,500 feet, temperature 21 degrees Celsius (C), dew point 12 C, altimeter setting 30.25. Density altitude (DA) conditions at the accident site location were about 9,500 feet, based on an accident site elevation of 7,630 feet and a standard temperature lapse rate from the KCEZ observation.

WRECKAGE AND IMPACT INFORMATION

The helicopter impacted into relatively flat, bush covered terrain and was found resting on its left side. The main fuselage had significant crushing to the nose section and left side. The skids exhibited bending to the left forward crosstube consistent with a left bank nose down attitude at ground impact.

Both composite main rotor blades were attached to the main rotor hub through blade bolts and drag braces. Each blade exhibited damage consistent with ground contact while rotating. The main rotor hub was intact except that the pitch horn from one main rotor blade had separated from its main rotor grip consistent with ground impact forces. The mast remained attached to the main rotor hub assembly and to the transmission. The main transmission chip detector was removed and exhibited no debris or chips. No pre-impact anomalies were observed with the main rotor hub, composite blades, or mast.

The flight controls and hydraulics system exhibited extensive damage from impact. The helicopter was equipped with dual flight controls. The pilot was flying from the left seat, with instrumentation on the left pilot door for external load operations. The pilot's cyclic stick and collective stick exhibited fractures consistent with overload near their mounting locations. The rotating controls exhibited continuity to the stabilizer bar and to each pitch change link and pitch horn. The hydraulic pump was removed from the hydraulic drive quill on the sump case and the splined driveshaft was intact. The splined driveshaft was rotated with pliers and minimal resistance occurred.

Engine examination revealed compressor shroud metal spray on the aft side of the 2nd stage power turbine, consistent with operation at the time of impact. Evidence of engine rotation at the time of impact included rotational scoring and tearing on the inner diameter of the particle separator housing assembly, as well as first stage axial compressor blades either broken from the drive hub or exhibiting rotational scoring/leading edge damage.

A follow on airframe examination was conducted at the salvage location. The left and right hydraulic servos were intact and the frame mounts exhibited multiple fractures consistent with overload. Due to the airframe structure damage, many hydraulic lines were fractured due to overload forces. No chafed hydraulic lines were observed.

The hydraulic switch was observed in the ON position. This hydraulic switch, located on the far right side of center pedestal, is out of immediate reach for a pilot flying from the left seat.

Light bulb filaments from the cockpit main annunciator panel, instrument panel annunciators, and pilot's auxiliary annunciator were examined for filament stretch with a USB connected microscope. Both of the bulb filaments for the hydraulic pressure annunciator light, as well as the single bulb filament for the auxiliary master caution light, appeared to be stretched. The remainder of the annunciator system bulb filaments did not appear to be stretched. Filament stretch of the hydraulic pressure annunciator and auxiliary master caution light bulbs was confirmed by the Bell Helicopter engineering laboratory.

Several hydraulic fluid drips were observed on hydraulic lines. A hydraulic check valve near the tail rotor control actuator servo could be rotated by hand between solid hydraulic lines and fittings. The hydraulic check valve and proximate hydraulic pressure line were intact and connected to undistorted walls in the aft belly compartment. In this same compartment, several rags were found soaked with hydraulic oil.

The external cargo hook was tested and responded accordingly when commanded to release both electrically and mechanically. The cargo hook electrical switch and manual cargo hook release could not be tested, due to damage.

MEDICAL AND PATHOLOGICAL INFORMATION

On July 27, 2013, an autopsy was performed on the pilot by a forensics pathologist at the Ertel Mortuary, Cortez, Colorado, as authorized by the Dolores County Coroner. The cause of death was attributed to blunt force injuries. The FAA's Civil Aeromedical Institute in Oklahoma City, Oklahoma, performed toxicology tests on the pilot. No carbon monoxide, ethanol, or drugs were detected during testing.

The pilot was wearing a headset, vice a helmet, during the accident sequence. The left seat, which the pilot was flying from, was equipped with a seat belt and shoulder harness. The seat belt right side attachment fitting was fractured. The shoulder harness was not connected to the seat belt and the straps were not restrained within the guide at the top of the seat.

TESTS AND RESEARCH

Hydraulic system components were examined and tested at the Bell Helicopter engineering laboratory, with oversight by FAA and NTSB personnel. Hydraulic bench testing revealed that the right cyclic, left cyclic, and collective hydraulic servos operated normally and did not exhibit evidence that would preclude normal operation prior to the accident. Testing of the hydraulic control panel, filter, and pump revealed no anomalies or leakage. Of the various hydraulic fixed lines and flexible hoses that were in a condition that allowed for testing, none exhibited evidence of leakages with the exception of two components: a leak was observed with one hydraulic return line near the transmission, as well as a leak to the hydraulic check valve/pressure line to the tail rotor control actuator servo near bulkhead station 211.

The hydraulic return line located near the transmission had 45 degree shear laps in the flareless fitting due to removed tubing material that allowed the sleeve to lap over itself during tightening. It could not

be determined if ground impact opened one of the sleeve laps, or if a noticeable 10 degree bend in the tube adjacent to the leak was impact-related.

The hydraulic check valve exhibited longitudinal cracks at both threaded ends. The cracks were a result of stress corrosion cracking, as evidenced by intergranular features, crack branching and corrosion. No material discrepancies were noted. Evidence of Teflon tape was present at the outlet end of the threads. Teflon tape is commonly used in plumbing applications to seal threads from leaking, but is not an approved material to be used with the hydraulic system.

The hydraulic line containing the hydraulic check valve near the tail rotor servo was pressure tested. The check valve exhibited a leak at a rate of about 100 cubic centimeters (cc) per minute at both 850 pounds per square inch gauge (psig) and 1,000 psig. At 1,000 psig, when the line was slightly cocked, the valve exhibited a leakage rate of about 300 cc in 45 seconds.

The hydraulic system has a total capacity of about 8 pints, including fluid within the reservoir, servos, and lines. The hydraulic reservoir has a capacity of about 5.3 pints. One pint is equivalent to about 473 cc.

TEST FLIGHT INFORMATION

In July 1988, US Army Aviation Engineering Flight Activity completed an airworthiness and flight characteristics evaluation report for the UH-1H with composite main rotor blades (CMRB) installed. Included in the report were the following conclusions:

"Hydraulic system failure characteristics were qualitatively and quantitatively evaluated … during approaches to running landings. A slight nose-down pitching moment upon failure was controlled by an approximate 15 pound aft longitudinal force. Increased right lateral control forces coupled with the onset of some control feedback required moderate pilot compensation to prevent pilot-induced oscillation (PIO) tendencies, causing an increase in control activity."

"The hydraulic system failure characteristics of the UH-1H helicopter with the hub spring and CMRB installed are acceptable; however, high altitude operations could be compromised due to the high collective control force encountered without hydraulics assist, thereby restricting control travel."

Following the accident, without FAA or NTSB awareness, two pilots from Billings Flying Service conducted an informal UH-1H flight test at high altitude. The flying pilot notified the NTSB of his findings during an interview. During a simulated long line profile with the hydraulics system turned off, the flying pilot observed a high amount of force was required to apply collective. While making his "hard pull" of the collective with his left arm, the pilot observed that he had a tendency to "brace" himself and push the cyclic to the right, causing a right bank. This tendency to bank right was not immediately recognized, since he was leaning left to simulate sighting for a long line operation. As he attempted to return to a level attitude (with the hydraulics system turned off) he overcorrected and entered into nearly 90 degrees of left bank. The pilot was very startled by the dramatic left bank and immediately directed the other pilot in the right seat to restore hydraulics system pressure to assist with recovery of the helicopter.

MAINTENANCE INFORMATION

The helicopter mechanic stated that hydraulic leaks had been a long-term challenge with the accident helicopter and that most of the hydraulic lines had been replaced as the helicopter was rebuilt and brought up to certification standards. While deployed to the Dove Creek location, a hydraulic line had been replaced six days prior to the accident, due to a leak near the transmission filter.

The mechanic, director of maintenance at home station, and accident pilot were aware of a slow, "weeping" hydraulic leak in the aft belly of the fuselage, but did not foresee the leak causing a significant issue. Replacement components for the hydraulic system near the leak, to include hydraulic lines, fittings, and a check valve, had been requested from home station, and were expected to arrive to the Dove Creek location within days of the accident. Information concerning a weeping hydraulic leak was not entered into the maintenance records.

On the day prior to the accident, the pilot told the mechanic that the cyclic appeared "notchy", as if it would "bump" a little during movement. The pilot thought the cyclic issue may have been associated with winds. Based on the pilot's comment about cyclic, the mechanic inspected for loose hardware, the main rotor hub, main rotor dampeners, and pitch change linkages on the controls in the vicinity of the swashplate. He did not observe any anomalies.

The mechanic stated that he added one or two cups of hydraulic fluid to the reservoir within a day or two of the accident. On the morning of the accident, the mechanic noticed the check valve fitting was not tight. He tightened several fittings in the surrounding area, utilized Teflon tape in an attempt to help the check valve fittings 'grab' more effectively, and used rags to soak up hydraulic fluid in the aft belly of the main fuselage.

ADDITIONAL INFORMATION

Billings Flying Service personnel described the operating environment at the Dove Creek survey location as 'tense'. About three days prior to the accident, an owner of Billings Flying Service terminated a contract pilot after the accident pilot informed the owner of this pilot's aggressive flying at the Dove Creek location. Following the termination, the accident pilot informed the owner that survey personnel were dissatisfied with losing the other pilot and blamed the accident pilot for the termination. According to the owner and the mechanic, survey personnel had 'timed' how long the accident pilot was taking to perform long line operations. A survey supervisor had informed the owner that the accident pilot was taking "50% longer" than the terminated pilot in performing these operations. The owner stated that the accident pilot was very concerned with losing the survey contract and told him that the work environment felt hostile. The mechanic stated that he also felt pressure to ensure flights were completed. The director of maintenance stated that the accident pilot and mechanic were concerned that any "maintenance down time" on the helicopter would result in a contract penalty.

Pilot Information

Certificate:	Commercial; Flight instructor	**Age:**	27
Airplane Rating(s):	Single-engine land; Multi-engine land; Multi-engine sea	**Seat Occupied:**	Left
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	Lap only
Instrument Rating(s):	Airplane	**Second Pilot Present:**	No
Instructor Rating(s):	Airplane multi-engine; Airplane single-engine; Helicopter	**Toxicology Performed:**	Yes
Medical Certification:	Class 2 Without waivers/limitations	**Last FAA Medical Exam:**	June 24, 2013
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	February 26, 2013
Flight Time:	(Estimated) 5000 hours (Total, all aircraft), 1800 hours (Total, this make and model), 5000 hours (Pilot In Command, all aircraft), 25 hours (Last 30 days, all aircraft), 3 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Bell	**Registration:**	N775AR
Model/Series:	UH-1H	**Aircraft Category:**	Helicopter
Year of Manufacture:	1977	**Amateur Built:**	
Airworthiness Certificate:	Restricted (Special)	**Serial Number:**	65-10067
Landing Gear Type:	Skid	**Seats:**	15
Date/Type of Last Inspection:	June 5, 2013 Annual	**Certified Max Gross Wt.:**	
Time Since Last Inspection:	41 Hrs	**Engines:**	1 Turbo shaft
Airframe Total Time:	14798 Hrs at time of accident	**Engine Manufacturer:**	Lycoming
ELT:	C91A installed, activated, did not aid in locating accident	**Engine Model/Series:**	T53-L-13B
Registered Owner:	BVDS INC	**Rated Power:**	1485 Horsepower
Operator:	Billings Flying Service	**Operating Certificate(s) Held:**	Rotorcraft external load (133)

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	KCEZ,5918 ft msl	**Distance from Accident Site:**	21 Nautical Miles
Observation Time:	09:53 Local	**Direction from Accident Site:**	163°
Lowest Cloud Condition:	8500 ft AGL	**Visibility**	10 miles
Lowest Ceiling:	Overcast / 8500 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	4 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	300°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.25 inches Hg	**Temperature/Dew Point:**	21°C / 12°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Dove Creek, CO	**Type of Flight Plan Filed:**	None
Destination:	Dove Creek, CO	**Type of Clearance:**	None
Departure Time:	09:53 Local	**Type of Airspace:**	

Wreckage and Impact Information

Crew Injuries:	1 Fatal	**Aircraft Damage:**	Substantial
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	1 Fatal	**Latitude, Longitude:**	37.756111,-108.773056

Administrative Information

Investigator In Charge (IIC):	Folkerts, Michael
Additional Participating Persons:	Rodney Martinez; Federal Aviation Administration; Salt Lake City, UT Scott Tyrrell; Federal Aviation Administration; Fort Worth, TX Mark Stuntzner; Bell Helicopter; Fort Worth, TX Jay Eller; Honeywell; Phoenix, AZ Jay Bugli; Tamarack Helicopters; Stevensville, MT Ebert Stanton; Billings Flying Service; Billings, MT
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