HISTORY OF FLIGHT

On January 2, 2013, at 2057 central standard time, a Bell Helicopter model 407, N445MT, impacted terrain near Clear Lake, Iowa. The pilot and two medical crew members sustained fatal injuries. The helicopter was destroyed. The helicopter was registered to Suntrust Equipment Leasing & Finance Corporation and operated by Med-Trans Corporation under the provisions of 14 Code of Federal Regulations Part 91 as a positioning flight. Night visual meteorological conditions prevailed for the flight, which was operated on a company flight plan in accordance with Part 135 of the aviation regulations. A flight plan was not filed with the Federal Aviation Administration. The flight originated from the Mercy Medical Center, Mason City, Iowa, about 2049, with an intended destination of the Palo Alto County Hospital, (IA76), Emmetsburg, Iowa.

A witness located about 1 mile south of the accident site, reported observing the helicopter as it approached from the east. He noted that it appeared to slow and then turn to the north. When he looked again, the helicopter appeared to descend straight down. He subsequently went back into his house and called 911. He described the current weather conditions as "misty," with a light wind.

A second witness reported that he was working in his garage when he heard the helicopter. He stated that the sound of the helicopter changed as if it was turning, followed by what he described as a "thump" and then everything was quiet. He subsequently responded to the accident with the Ventura Fire Department. He reported that there was a coating of ice on his truck windshield that the wipers would not clear. He decided to drive another car to the fire stations because it had been parked in the garage. He was on the third fire truck out of the station and as they were waiting to cross Highway 18 at Balsam Avenue, they observed a Clear Lake police car, also responding to the accident, slide through the intersection. They informed dispatch to advise following units to expect slick road conditions. He noted that there was a haze in the air, which was evident when looking toward a street light; however, he did not recall any precipitation at the time.

A pilot located at the Mason City Municipal Airport (MCW) reported that he saw the helicopter fly overhead and estimated its altitude as 300 feet above ground level (agl). He was leaving the airport at that time and noted there was a glaze of ice on his car. He added that the roads were icy as he drove out of the airport and onto Highway 18. He commented that he had flown into Mason City about 1830 and encountered some light rime ice while flying through a cloud.

GPS tracking data depicted the helicopter at the medical center at 2049:44 (hhmm:ss). After liftoff, the helicopter proceeded westbound along Highway 18 about 1,800 feet mean sea level (msl). The helicopter passed just south of the Mason City airport at 2052:44. About 2056:09, the helicopter entered a right turn, becoming established on a northbound course about 10 seconds later. The helicopter simultaneously entered a climb, ultimately reaching approximately 2,995 feet msl at 2057:04. About one minute prior to reaching the apex of the climb, the helicopter entered a left turn, which continued until the helicopter was established on a southbound course. The final tracking data point was recorded at 2057:14. The final data point was located about 774 feet north of the accident site, with an associated altitude of 2,723 feet msl. The published field elevation of the Mason City airport was 1,214 feet.

The helicopter impacted a harvested agricultural field. The main wreckage came to rest along a line of trees and bushes separating the fields. The debris path was about 100 feet long and was oriented on a 246-degree magnetic bearing.

PERSONNEL INFORMATION

The pilot held an airline transport pilot certificate with helicopter and single-engine airplane ratings; his airplane rating was limited to private pilot privileges. He was issued a second class airman medical certificate on April 17, 2012, with a limitation for corrective lenses.

The pilot completed the operator's new hire training program on September 24, 2012, with night vision goggle (NVG) training completed on September 27, 2014. The pilot's Part 135 checkride was completed on September 29, 2012, and his new hire base training was completed on October 5, 2012.

At the time of his initial employment, the pilot reported having accumulated a total flight time of 2,808 hours, with 2,720 hours in helicopters. Of that total flight time, 248 hours were at night. Duty and flight time records indicated that during October, the pilot accumulated 3.7 hours of flight time, all in daylight conditions. During November, the pilot accumulated 9.9 hours total flight time. Of that flight time, 3.1 hours were at night with the aid of NVGs. During December, the pilot accumulated 5.6 hours, all of which were at night, with 5.4 hours using NVGs. His most recent flight for the operator was December 21, 2012.

The pilot was on-duty for 12 hours the day before the accident, but did not log any flight time during that shift. The pilot reported for duty at 1820 on the evening of the accident.

AIRCRAFT INFORMATION

The accident aircraft was a Bell Helicopter model 407, serial number 53959. The helicopter was configured for helicopter emergency medical services (HEMS) operations. The FAA type certificate required one flight crew member (pilot) and permitted operations under day or night visual flight rules (VFR). The helicopter was not certificated for intentional flight into known icing conditions. The operator noted that the helicopter was equipped for instrument flight; however, it was not certified for flight under instrument flight rules (IFR). The helicopter was equipped with heated pitot and static ports; however, the rotor blades were not equipped with ice protection. The helicopter was powered by a Rolls-Royce Allison model 250-C47B turboshaft engine, serial number CAE-847212, with maximum takeoff and maximum continuous power ratings of 650 and 600 shaft horsepower, respectively.

The helicopter was issued a normal category standard airworthiness certificate in June 2009. The helicopter was purchased by Sun Trust Equipment Finance on April 29, 2010, and subsequently leased by Med-Trans Corporation. The helicopter was maintained under an approved aircraft inspection program. The most recent inspection was completed on December 28, 2012, at 952.2 hours total airframe time. A review of the available maintenance records did not reveal a history of outstanding maintenance discrepancies. At the time of the accident, the helicopter airframe and engine had accumulated about 956 hours total time.

The engine anti-ice system is controlled by a switch on the overhead panel. When activated, the system routes air from the diffuser scroll to the engine compressor front support guide vanes in order to prevent the formation of ice. In the event of a loss of electrical power, the system will be activated and route hot air to the engine guide vanes.

METEOROLOGICAL CONDITIONS

The Mason City Municipal Airport Automated Surface Observing System (ASOS), located about 7 miles east of the accident site, at 2053, recorded weather conditions as: wind from 300 degrees at 8 knots; 8 miles visibility; broken clouds at 1,700 feet agl, overcast clouds at 3,300 feet agl; temperature -3 degrees Celsius; dew point -5 degrees Celsius; and an altimeter setting of 30.05 inches of mercury. At 2100, the recorded conditions included a wind from 310 degrees at 9 knots, broken clouds at 1,700 feet agl, and overcast clouds at 3,300 feet agl. At 2105, the wind was from 310 degrees at 10 knots, with broken clouds at 1,500 feet agl and overcast clouds at 2,000 feet agl. At 2110, the wind was from 310 degrees at 12 knots, with overcast clouds at 1,500 feet agl.

The Forest City Municipal Airport Automated Weather Observing System (AWOS), located about 8 miles northwest of the accident site, at 2055, recorded conditions as: wind from 300 degrees at 9 knots; 10 miles visibility; overcast clouds at 1,000 feet agl; temperature -2 degrees Celsius; dew point -3 degrees Celsius; and an altimeter setting of 30.04 inches of mercury. At 1955, about one hour before the accident, the observation included a note of unknown freezing precipitation. However, this notation was not included in the subsequent observations.

The MCW terminal forecast, issued at 1959, expected wind from 250 degrees at 6 knots, 5 miles visibility in light snow, and overcast clouds at 1,400 feet agl.

Satellite imagery depicted an overcast layer of stratiform clouds over the region with cloud tops near 11,000 feet. The regional radar mosaic for Iowa did not depict any significant meteorological echoes in the vicinity of the accident site about the time of the accident. However, the radar scan sampled the airspace from about 6,630 feet to 15,100 feet over the accident site. Any echoes below this height would not have been detected by the weather radar.

Pilot reports (PIREP) filed between 1500 and 2400 over Iowa indicated light to moderate rime ice ranging in altitude from 3,500 feet msl to 8,500 feet msl. These reports ranged from Sioux City, at the western end of the state, to Dubuque at the eastern end of the state. The closest PIREP was over Spencer, Iowa, about 70 miles west of the accident site where a pilot reported light rime icing during climb at 6,400 feet msl. This was about 23 miles west of the accident flight intended destination.

An Airman Meteorological Information (AIRMET) advisory for icing was current for the route of flight. AIRMET Zulu was issued at 2045 and was in effect until 0600. It warned of moderate icing conditions below 10,000 feet msl, with icing conditions expected to continue through 0900.

Witnesses and first responders reported mist, drizzle, and icy road conditions at the time of the accident. One first responder reported observing a police car slide through a roadway intersection due to the slick conditions while responding to the accident site.

WRECKAGE AND IMPACT INFORMATION

The helicopter impacted a harvested agricultural field. The debris path was about 100 feet long and was oriented on a 246-degree magnetic bearing. The helicopter was fragmented, and the cockpit and cabin areas were compromised. A postimpact fire ensued. The main wreckage consisted of the main rotor blades, transmission, engine, portions of the fuselage, and the tail boom. The tail rotor had separated from the tail boom and was located about 80 feet east-northeast of the main wreckage. The landing skids had separated from the fuselage. The left skid was located at the initial impact point; the right skid was located about 35 feet west of the main wreckage.

The main rotor blades remained attached to the hub; however, each blade exhibited bending and delamination consistent with ground impact. Separations of the pitch change links and one pitch change horn were consistent with overstress. The main rotor transmission remained attached to the fragmented upper fuselage bulkhead. The transmission drive input/output shafts and main rotor mast rotated freely. Examination of the freewheeling unit revealed that the shaft had fractured at the main rotor drive spline and at the tail rotor drive spline. Appearance of the fracture surfaces was consistent with overstress failures.

The flight control system was fragmented similar to the overall airframe structure. Separations of the control tubes and support brackets appeared consistent with overstress failures. The hydraulic actuator servos remained secured to the mating fuselage bulkhead; however, the attached fuselage structure was separated from the surrounding airframe panels. Portions of the servos were deformed consistent with impact forces. The mating control system push-pull tubes and hydraulic lines remained secured to the servos.

The tail boom was separated at the forward end and was located with the main wreckage. The tail boom remained straight from forward to aft ends; however, the tail boom cross-section was deformed at both ends. The tail rotor assembly was separated from the boom. The tail rotor blades were deformed and fragmented consistent with impact forces; however, both blades remained secured to the hub. The pitch change links were intact; although, the green pitch change link was deformed. Continuity within the gearbox was confirmed via rotation of the output drive mast. The forward portion of the tail rotor drive shaft remained attached to the tail boom. A separation of a section of the drive shaft near the horizontal/vertical stabilizers appeared consistent with a main rotor strike at that location. The tail rotor bearing supports remained attached to the tail boom except for one support located near the horizontal stabilizer, which was separated from the tail boom and remained attached to the separated section of the tail rotor drive shaft. The bearings appeared intact.

A postaccident examination of the engine was performed under the direct supervision of an NTSB powerplant specialist. The engine exhibited deformation of several components, which appeared consistent with impact forces. The hydro-mechanical unit (HMU) was partially separated from the accessory gearbox; the HMU drive shaft was fractured consistent with an

overstress failure. The compressor impeller blades, the impeller inducer shroud, gas producer rotor, and power turbine rotor exhibited rub marks consistent with rotation at impact. The power turbine N2 coupling was fractured near the forward spline consistent with tensile overload. The accessory gearbox components appeared intact and rotated freely. The engine bearings appeared intact, were oil wetted, and rotated freely. Dirt and corn stalk debris was observed throughout the engine air flow path. No anomalies consistent with a preimpact failure or malfunction were observed.

MEDICAL AND PATHOLOGICAL INFORMATION

An autopsy of the pilot was completed at the Mercy Medical Center, Mason City, Iowa, on January 3, 2013. The pilot's death was attributed to multiple blunt force injuries sustained as a result of the accident. FAA Civil Aerospace Medical Institute toxicology testing was negative for all substances in the screening profile.

TESTS AND RESEARCH

Helicopter engine operation was controlled by a Triumph Engine Control Systems, formerly Goodrich Pump & Engine Controls, model EMC-35R Engine Control Unit (ECU), serial number JG09ANU1247. One corner of the ECU housing was broken out, exposing a portion of the underlying circuit board. The non-volatile memory components related to the primary and reversionary governors was downloaded. The total ECU and engine operating times were 1,196.80 hours and 1,003.06 hours, respectively.

The ECU did not provide for continuous recording of engine parameters. However, the unit did record engine fault and incident data. The ECU incorporated primary and reversionary governor systems, which provided redundancy for engine operation. ECU data was organized into engine history, last engine run faults, time stamped faults, accumulated faults, and incident data. Time data associated with each fault or incident corresponded to the engine run time. Upon logging of a fault or incident event, the ECU also recorded 12 seconds of pre-event data into non-volatile memory.

The last engine run fault data files associated with both the primary and reversionary governors did not contain any fault codes. The time stamped fault data file associated with the primary governor did not contain any fault codes. The time stamped fault data file associated with the reversionary governor contained a total of 21 faults. The most recent fault was recorded at 733 hours ECU operating time. Because the current engine operating time was about 1,003 hours, the most recent fault was recorded about 270 hours before the end of data, which was well before and not relevant to, the accident flight. The reversionary governor accumulated fault data file contained only faults also recorded into the time stamped fault data file.

Three incidents were contained in the snapshot data file. The first was recorded at 1,003:06:16.344 (hh:mm:ss.sss) engine operating time and consisted of a high engine torque event of 110 percent. The associated 12 seconds of pre-event data were unremarkable, with engine speed, rotor speed, and engine torque parameters within normal limits. The collective pitch parameter was about 58 percent and the fuel flow about 452 pounds per hour (pph) during

this timeframe. Cyclic and anti-torque pedal positions were not recorded by the ECU. The second snapshot was recorded at 1,003:06:22.873 and consisted of a high power turbine event of 108 percent. An engine overspeed parameter is set due to this event. In addition, the collective pitch parameter had decreased to 32 percent and fuel flow to 36 pph at this time. The third snapshot was recorded at 1,003:06:22.920 and consisted of a high rotor speed of 109 percent. The loss of subsequent data was consistent with a loss of electrical power to the ECU at impact. In addition, the engine and rotor overspeed events, in conjunction with a decreasing fuel flow and collective pitch, was consistent with the rotor system being aerodynamically driven above 100-percent, such as in the descent prior to impact.

ADDITIONAL INFORMATION

Light bulb filaments from the caution and warning panel were examined by the investigator-in-charge at the NTSB materials laboratory. The filaments associated with the cyclic centering, engine anti-ice, engine overspeed, and hydraulic system exhibited stretching consistent with illumination at the time of impact.

According to the aircraft flight manual, the cyclic centering annunciator light will be illuminated when the helicopter is on the ground and the cyclic stick is not centered. The engine anti-ice annunciator will illuminate when the engine anti-ice system is activated. Engine overspeed annunciation is provided when an overspeed condition is detected by the ECU. Hydraulic system indication is provided when the system pressure decreases below 650 psi. The normal hydraulic system operating pressure is 1,000 psi.