NTSB Identification: LAX04TA017

HISTORY OF FLIGHT

On October 16, 2003, at 1650 mountain standard time, a MD Helicopter, Inc. **(MDHI) 900, N179PA,** collided with terrain and rolled over near Fredonia, Arizona. The National Park Service (NPS) was operating the helicopter as a public-use flight under the provisions of 14 CFR Part 91. The pilot and four passengers were not injured; the helicopter sustained substantial damage. The local public-use flight departed the Bear Dip site (located at the North Rim of the Grand Canyon) about 1610. Visual meteorological conditions prevailed, and a NPS company flight plan had been filed.

In a written statement, the pilot reported that the flight originated earlier in the day from the South Rim helibase. He made stops at both the North Rim helibase and the Big Dip site in an effort to pickup passengers to perform reconnaissance over numerous fires in the local area. After the helicopter was en route about 30 to 40 minutes, the pilot proceeded back to the Big Dip site with the intention to land, enabling a passenger to disembark. While approaching the vicinity from the southeast, he noted that the winds were light and opted to touchdown in the same location that he had landed the helicopter earlier in the day.

The pilot further stated that he configured the helicopter to make a slow, yet steep approach path, equating to a decent rate of about 400 to 200 feet per minute. After passing over a group of trees, while the helicopter was about 15 to 30 feet above ground level (agl) and 60 feet from the intended touchdown location, the helicopter began a rapid, uncommanded right yaw. The helicopter began to spin toward the right and the pilot input full left pedal pressure in an effort to stop the rotation. Despite his attempts, the pilot's control inputs had no effect on the helicopter, which he thought was akin to the controls being disconnected. The helicopter continued to spin, making around two to four rotations, and the pilot lowered the collective while simultaneously closing the throttle controls. Only able to retard the left engine throttle, the pilot maneuvered the helicopter away from the trees as it continued to descend. Upon touchdown, the helicopter rolled on its left side, and the main rotor blades impacted the terrain.

The pilot noted that he never heard any unusual noises before the helicopter began the accelerated spin to the right. When the pilot queried the passengers if they heard or felt any anomalies with the helicopter prior to the loss of control, they all reported that they did not hear or see anything abnormal.

Post accident examination of the helicopter control systems revealed that the force limiting control rod had broken inside the spring capsule assembly. The force limiting control rod (part number 900C6010239-107), manufactured by Kaiser Electroprecision, was retained for further examination.

PERSONNEL INFORMATION

A review of the Federal Aviation Administration (FAA) airmen records revealed that the pilot held commercial pilot and certified flight instructor certificates with rotorcraft privileges. In addition, the pilot possessed a second-class medical certificate, which was issued on June 17, 2003, having the restriction that he must wear corrective lenses. In a written report signed by the operator's director of operations, he disclosed that the pilot had 10,032.2 total flight hours, of which about 9,530.2 hours were flown in rotorcraft. His total experience piloting the MD 900 and the flight hours he acquired in the same make and model helicopter during the 90-day period preceding the accident, was 547 and 120.5 hours, respectively.

The pilot satisfactorily passed an Airman Competency/Proficiency Check- FAR135 on January 15, 2003, in an MD900. In addition, the pilot was issued an USDA/USDI Interagency Helicopter Pilot Qualification card on December 11, 2002, with the following helicopters listed: MD900, BH407, and Bell 206.

HELICOPTER INFORMATION

Certification and Operations Base.

The FAA issued the normal category helicopter (serial number 900-00021) a standard airworthiness certificate on September 17, 1996. On May 26, 1998, the FAA registered the helicopter in the name of Gulf, Inc. The helicopter was physically based in Grand Canyon, Arizona, where Papillion Airways operated the helicopter for exclusive use to the Grand Canyon National Park.

NOTAR Anti-Torque system.

According to MD Helicopters, the MD900 anti-torque system, known as NOTAR (no tail rotor), consists of an enclosed variable-pitch fan that is driven by the main transmission. The fan produces a low-pressure and high-volume of ambient air, which in turn pressurizes the composite tail boom. As low-pressure air is directed through two circulation control slots located in the tail boom, the main-rotor downwash follows that expelled air with the contours of the boom. This phenomenon of creating lateral lift to counteract main rotor torque provides a majority of the anti-torque force required while in a hover configuration, and is referred to as the "Coanda Effect." Additional anti-torque and directional controllability is accomplished by a rotating thruster affixed to the end of the tail boom, which is manipulated by the pilot via the use of anti-torque pedals. According to MDHI engineers, during hover the Coanda effect produces approximately 70 percent of the helicopter's anti-torque force, while the thruster produces the remaining 30 percent. During normal cruise, two parallel vertical stabilizers provide most of the anti-torque, while the thruster is the primary manipulator of directional control.

The MD Pilot Training Manual for the NOTAR Anti-Torque System states that the anti-torque pedals, located on the floor in front of both the pilot and copilot's seats, are connected to anti-torque linkages consisting of push-pull tubes, bell cranks, and control rods. Those linkages are routed under the cockpit, up the bulkhead located behind the pilot's seat, and continue aft along the cabin roof, until connecting to a directional servo-actuator.

The directional servo-actuator hydraulically transfers the control input to a splitter assembly, which function is twofold; adjusting the pitch of the NOTAR fan blades and rotating the direct jet thruster to the commanded position. At the splitter assembly, a force limiting control rod manipulates the fan blade pitch, while another control goes to the left vertical stabilizer and jet thruster cone by way of a two-part thruster cable, which terminates at a bell crank beneath the horizontal stabilizer. The bell crank transmits motion via another cable to a pulley assembly that rotates the jet thruster cone. The cables are flexible and have a quick disconnect fitting at the tail boom to fuselage junction, which joins the forward cable to the center cable. A left pedal input pulls the cable forward and applies a tension load, whereas a right pedal input is designed to apply a compression load. The jet thruster cone rotates on the end of the tail boom to direct the high-volume, low-pressure air to the corresponding position of the pedal selected. The circulation control tail boom, jet thruster assembly, horizontal stabilizer, and two vertical stabilizers comprise the remaining components of the anti-torque system.

The MD Rotorcraft Flight Manual states that in the event of an anti-torque failure where the helicopter experiences a complete loss of thrust during low hover conditions, the helicopter will begin an uncommanded turn to the right and will not respond to the pilot's control inputs. According to an MDHI engineer, if the force limiting control rod were to separate, the NOTAR fan blades were designed to move toward a neutral pitch setting.

NOTAR Force Limiting Control Rod and Maintenance.

A review of the helicopter's maintenance records indicates that since May 1998, the helicopter was maintained and operated by Papillon personnel. Papillon reported that they had performed annual inspections and maintenance in accordance with FAA requirements, manufacturer's recommendations, and pilot-noted discrepancies.

A warranty repair Service and Operations Report for N179PA disclosed that on December 31, 2001, several pilots reported an apparent loss of motion from the directional pedal inputs while in a hovering and approach to land configuration. This resulted in the helicopter not initially responding to small pedal inputs. A visual inspection of the fan pitch control linkages revealed that the portion of the rod end extruding from the spring capsule assembly had approximately 3/16 inches of range movement. After examining the motion of the NOTAR fan blades, a mechanic found a "dead spot" in the pitch control. He removed the control rod assembly, replacing it with an identical new part (p/n 900C2010239-107). Upon completion of the new control rod assembly installation, the helicopter was test flown, and the test pilot reported no anomalies, noting that that helicopter responded immediately to minute pedal inputs.

The aircraft logbook reflected the following entry regarding control rod assembly maintenance on December 31, 2001, at a helicopter total time of 1,981.8 hours: "Found excessive play in the spring capsule assembly rod end. Removed control rod assembly 900C6010239-105, s/n 009238-0013. Installed new control rod assembly p/n 900C2010239-107, s/n 009238-0064. All work preformed I.A.W. [in accordance with] MDHI maintenance manual section 67-20-00 pg.420." The control rod was installed on the helicopter about 779 hours prior to the accident.

METEOROLOGICAL INFORMATION

The closest aviation weather observation station is Grand Canyon National Park Airport, located about 25 nautical miles (nm) south of the accident site. Several minutes after the accident, it reported the following: winds from 220 degrees at 6 knots; skies clear; visibility 10 statute miles; temperature 22 degrees Celsius; dew point -08 degrees Celsius; altimeter 30.36 inHg.

WRECKAGE AND IMPACT INFORMATION

The global positioning system (GPS) coordinates for the estimated 8,970-foot mean sea level (msl) accident site were: 36 degrees 22.69 minutes north latitude by 112 degrees 09.49 minutes west longitude. The accident site was located at Bear Dip site, a clearing comprised of grass and dirt that is surrounded by a dense population of mature tees. Situated on level terrain, the helicopter came to rest on its left side, with the wreckage oriented on a southwest bearing. Investigator's examination of the initial point of impact revealed an elongated ground scar similar in dimensions to those of a skid. To the east of the main wreckage, investigators located several large trees with branches severed in angular cuts.

TESTS AND RESEARCH

Metallurgical Information, SEMTEC Laboratories.

Under the auspices of a Safety Board investigator, an examination of the force limiting control rod was performed at SEMTEC Laboratories, Inc., Phoenix, Arizona.

The force limiting control rod was comprised of two components: a larger rod, which was affixed to a cable, and a smaller threaded rod with two nuts attached and secured with safety wire. To ascertain the nature of the separation, the rod assembly's striations and fracture surfaces were examined using a scanning electron microscope (SEM). The more intact fracture surface on the smaller rod displayed a relatively flat area with beachmarks, which the SEMTEC technician attributed to a fatigue fracture; the

fatigued portion represented 86 percent of the total cross-section surface. He noted no damage sites, foreign material inclusions, or other potential fracture initiating conditions.

In a written report, the SEMTEC technician reported that the fatigue striations were closely spaced, in indication that the fatigue fracture prorogated prior to overload failure. He stated that it appeared that the part was induced to light loading, or low cyclic stress, and the fatigue fracture was akin to an aluminum fracture where significant time passes between initiation and completion of the fracture. The examination further revealed that there was not one single, point source of fatigue, rather, the fracture started along the thread root, about 25 percent of the circumference. The overload region consisted of a dimpled surface stretched along the surface, which the technician stated was consistent to the overload failure occurring while the part was in tension.

Energy dispersive spectroscopy (EDS) analysis of the component's metal showed results consistent with 2024 aluminum alloy.

ADDITIONAL INFORMATION

Following the accident, MDHI issued a Service Bulletin implementing a fail-safe device for the force limiting control rod. The fail-safe device is comprised of two lanyards that are affixed to each end of the rod component in an effort to prevent separation should another rod experience a fatigue failure. An inspection of the fail-safe device is required during each preflight. On August 25, 2004, the FAA issued airworthiness directive (AD) 2004-16-08, which required the implementation of the fail-safe device and preflight check of the device during the first flight of the day.