HISTORY OF FLIGHT

On December 29, 2014, at 1025 eastern standard time, a Robinson R22 Beta, N771MM, was substantially damaged when it impacted terrain while performing an autorotation near Palm Beach County Park Airport (LNA), Lake Worth, Florida. The flight instructor (CFI) was fatally injured, and the student pilot sustained serious injuries. Visual meteorological conditions prevailed, and no flight plan was filed for the local instructional flight, which departed about 0940. The flight was operated by Palm Beach Helicopters, Inc., and was conducted under the provisions of Title 14 Code of Federal Regulations Part 91.

A witness, who was a CFI, reported that he and a student were taxiing their airplane to runway 15 for takeoff when they heard the accident helicopter announce its position on a right base leg, with the intent to conduct an autorotation to taxiway Bravo. The CFI then offered to hold at the airplane's present position to allow the helicopter more room to conduct the maneuver. He stated that the helicopter pilot thanked him, and shortly thereafter, he observed the helicopter enter a "rapid descent typical of [autorotation]" from an altitude of between 800-1,000 feet above ground level (agl). About 500 feet agl, the helicopter appeared to level off, then pitched abruptly nose-down and descended to ground contact. Just prior to impact, he heard a panicked radio transmission from the helicopter that was mostly unintelligible. He also stated that, based on the accent he heard, he believed the CFI onboard the helicopter was conducting all radio transmissions.

Another CFI, who was taxiing a helicopter with a student on the south side of the airport, reported hearing the accident helicopter transmit, "we're going in the grass" over the airport's common traffic advisory frequency. Shortly thereafter, an airplane in the airport traffic pattern reported that there was a helicopter down, and the CFI in the helicopter flew to the accident site to render assistance.

In a statement to law enforcement two days after the accident, the student pilot recounted that he and the CFI were practicing autorotations following a simulated engine failure. The student stated that he could not recall whether he or the CFI initiated the autorotation. About 100 feet above ground level, the CFI said, "We're going down, we're going down," and at that time, the CFI was controlling the helicopter. The student stated that, until that point, the autorotation had "appeared pretty normal," and he added, "I don't know if the engine cut off, or the engine didn't turn back on."

In a subsequent interview, conducted about two weeks after the accident, the student stated that the flight was Lesson 2 in Stage 3 of the school's private pilot training course. He reported that he could not recall most of the accident flight, but recalled that prior to the accident, he and the CFI had been flying for approximately 40 minutes and had conducted 2 or 3 steep approaches as well as a maximum-performance takeoff. The accident autorotation was the first of the accident flight. He stated that he could not recall who initiated the autorotation or the rotor rpm indication during the maneuver. He remembered that the CFI was controlling the helicopter as it descended through about 100 feet above ground level, and as the CFI rolled on the throttle in an attempt to recover, there was no response from the engine. The CFI stated, "We're going down, we're going down." The student also stated that, on the downwind leg of the traffic pattern, he observed the

CFI using his cell phone and stated that he appeared to be conducting a video call, as he briefly saw someone on the phone's screen. He stated that the CFI turned the phone to face outside of the helicopter as if he was showing the view out the helicopter's windscreen to the individual on the phone. He could not recall when the CFI discontinued the use of the phone.

In a written statement provided after the interview, the student recalled that the CFI "asked for the controls," on the downwind leg of the traffic pattern prior to entering the autorotation. The student stated that he "handed over the controls and looked south out my door enjoying the view." The student then recalled looking at the ground "in a nose down attitude" as the helicopter descended, and seeing the CFI "fighting with the cyclic and collective."

Surveillance video from a building near the accident site captured approximately the last 2 seconds of the flight before impact, and showed the helicopter descending rapidly at a steep angle.

PERSONNEL INFORMATION

The CFI held commercial pilot and flight instructor certificates, both with ratings for rotorcraft-helicopter and instrument helicopter; as well as an airframe and powerplant mechanic certificate. His most recent Federal Aviation Administration (FAA) first-class medical certificate was issued in March 2014. Review of operator records revealed the CFI had about 397 total hours of flight experience, of which about 280 hours were in the accident helicopter make and model. He had accumulated about 121 hours of flight instruction given.

The student held an FAA second-class medical and student pilot certificate, which was issued in December 2012. He reported about 37 total hours of flight time, all of which was in the accident helicopter make and model.

AIRCRAFT INFORMATION

The helicopter was manufactured in 1996 and was equipped with one Lycoming O-360 series, 145 hp reciprocating engine. Review of maintenance records provided by the operator indicated that the helicopter's most recent 100-hour inspection was completed on December 1, 2014. At that time, the airframe had accumulated a total time of 4,162.9 hours, and the engine had accumulated 1,978.7 hours since its most recent overhaul. The helicopter's 2,200-hour inspection was completed on February 13, 2013 at a total airframe time of 2,184.2 hours.

METEOROLOGICAL INFORMATION

The 0953 automated weather observation at PBI recorded wind from 180 degrees at 7 knots, 10 miles visibility, scattered clouds at 2,100 ft, temperature 26 degrees C, dew point 22 degrees C, and an altimeter setting of 30.13 inches of mercury. Review of a carburetor icing probability chart revealed the potential for serious carburetor icing at glide power.

WRECKAGE AND IMPACT INFORMATION

The helicopter came to rest on its left side in a grassy area about 700 feet northwest of the runway 15 threshold at LNA. The wreckage path was oriented approximately 140 degrees magnetic, and extended about 75 feet from the initial impact point to where the fuselage came to rest. The initial impact point was identified as a large metal stake, about 3 feet in height. The second point of impact was a small crater measuring about 4 feet long and 1 foot deep, located about 15 feet past the initial impact point. A portion of the forward skid crosstube was located in the crater. The vertical stabilizer, horizontal stabilizer, and portion of the tail rotor came to rest next to the crater. The tail boom was separated from the fuselage, and fractured into several pieces, some of which displayed signatures consistent with main rotor blade contact. The skids separated from the fuselage and were fractured into several sections, which were located along the wreckage path.

The fuselage exhibited downward crushing, and the cabin was fractured aft of the seat structures. Both the auxiliary and main fuel tanks were intact and contained fuel, and both fuel caps were secure. The fuel vent tubes were separated from the auxiliary tank by impact, which allowed fuel to drain from the tanks following the accident.

The main rotor remained attached to the fuselage. One blade was bent up and displayed several chordwise creases along its span. The second blade was bent up about 45 degrees near its root. Neither blade displayed significant leading edge damage. The tail rotor drive shaft separated from the helicopter during the accident sequence, and a 5-foot portion was located about 500 feet west of the main wreckage. The aft portion of the tail rotor drive shaft was not recovered.

The helicopter was removed from the accident site and transported to a secure facility for further examination. Flight control continuity was confirmed from the cockpit area to the main rotor system. Tail rotor control continuity was established from the cockpit to the intermediate flex coupling. The main rotor gearbox rotated smoothly by hand with no anomalies observed. Examination of the v-belts, sheaves, and overrunning clutch also revealed no anomalies. Tail rotor drive continuity was established from the upper drive sheave to the intermediate flex coupling. The tail rotor gearbox rotated smoothly, with no anomalies noted.

The engine remained attached to the airframe at its mount. The mixture control wire was impact-separated from the mixture control arm. The carburetor heat control was bent, and was in the off position. The carburetor air box was partially crushed, and the carburetor heat slider valve was in a mid-travel, partially open position. The carburetor remained attached to the engine, and the throttle control arm was observed about 1/8 inch from the full-throttle position. The exhaust system was partially crushed. The sparkplugs were removed and displayed normal wear characteristics. The engine was rotated by hand at the cooling fan, and thumb compression was obtained on all cylinders. Crankshaft continuity was established to the accessory gears. Oil was added to the engine to facilitate a test run, and when power was applied to the engine starter, the engine started, accelerated, and ran continuously for several minutes utilizing the fuel onboard. A magneto check was performed with no anomalies noted.

The engine was shut down, and the carburetor, oil filter, and oil suction screen were removed for examination. The carburetor float bowl contained blue liquid consistent with 100LL aviation

fuel, and did not display any sign of contamination. There was no damage to the internal components of the carburetor, and the fuel inlet screen was absent of debris.

MEDICAL AND PATHOLOGICAL INFORMATION

An autopsy was performed on the CFI by the Office of the District Medical Examiner, District 15, Palm Beach County, Florida. The cause of death was identified as blunt force injuries. Toxicological testing was performed by the FAA Bioaeronautical Sciences Research Laboratory in Oklahoma City, Oklahoma. Testing was negative for carbon monoxide, ethanol, and all tested-for drugs and their metabolites.

ADDITIONAL INFORMATION

Cell Phone Information

The CFI's cell phone was retained for examination in the NTSB vehicle recorders laboratory; however, the device was passcode-protected and could not be unlocked. Usage records obtained from the cellular service provider could not conclusively determine whether the phone was in use at the time of the accident.

Practice Autorotations

According to the pilot training syllabus provided by the flight school, the objective of Stage 3, Lesson 2 was for the student to practice advanced maneuvers and procedures, including normal and steep approach, normal and maximum performance takeoff, hovering, hover taxi, air taxi, ground reference maneuvers, emergency operations, autorotation to a power recovery, loss of tail rotor, stuck pedal, hovering out of ground effect, and confined area operation.

Review of the student's training record indicated that he completed Stage 2 of the syllabus on December 23, 2014. Instructor notes for the previous flight, dated December 22, 2014, indicated, "gap in training is evident in proficiency, basic straight [and] level unsatisfactory, [aeronautical decision making] needs work, approaches need work."

The flight school specified that all 180-degree and straight-in autorotations be terminated with a power recovery throughout the private pilot training course. School policy stated that all landings and practice autorotations were ~~School policy also stated that landings and autorotations at LNA were~~ to be performed to a hard-surfaced runway or taxiway. ~~runways. or to the grassy areas next to runways 15/33 and 09/27~~.

The flight school's written procedures for a straight-in autorotation with power recovery indicated that the maneuver should be initiated at an altitude of 700 feet agl after clearing the area for potential traffic conflicts and applying carburetor heat. Upon selecting a landing site, the autorotation was entered by lowering the collective to its full-down position, then rolling the throttle to the full idle position, where the procedure specified it should be held "firmly against the stop for the remainder of the autorotation." About 40 feet agl, the recovery was initiated by applying aft cyclic to bring the helicopter to a skids-level attitude, where it was held for 3

seconds prior to entering a flare. At that time, the throttle was "crack[ed] open" to allow the rpm governor to operate, forward cyclic applied, and the collective raised to bring the helicopter to a hover about 5 feet agl. The maneuver guide also stated, "Make an IMMEDIATE power recovery if the following conditions do not exist through 100' AGL: Aircraft aligned with touchdown point; Rotor RPM in the green; Airspeed within +/- 5 [knots] of 65 [knots]; Rate of descent <1,500 fpm".

The manufacturer's Pilots Operating Handbook outlined the following procedure for a practice autorotation with a power recovery: "1. Adjust carb heat as required. 2. Lower collective to down stop and adjust throttle as required for small tachometer needle separation. CAUTION: To avoid inadvertent engine stoppage, do not chop throttle to simulate a power failure. Always roll throttle off smoothly for a small visible needle split. 3. Adjust collective to keep rotor RPM in green arc and adjust throttle for small needle separation. 4. Keep airspeed 60 to 70 KIAS. 5. At about 40 feet AGL, begin cyclic flare to reduce rate of descent and forward speed. 6. At about 8 feet AGL, apply forward cyclic to level aircraft and raise collective to control descent. Add throttle if required to keep RPM in green arc."

Robinson Helicopter Company Safety Notice SN-38, "Practice Autorotations Cause Many Training Accidents," stated, "There have been instances when the engine has quit during practice autorotation. To avoid inadvertent engine stoppage, do not roll throttle to full idle. Reduce throttle smoothly for a small visible needle split, then hold throttle firmly to override governor. Recover immediately if engine is rough or engine RPM continues to drop."

Safety Notice SN-24, "Low RPM Rotor Stall Can Be Fatal," stated, "Rotor stall is very similar to the stall of an airplane wings at low airspeeds. As the airspeed of an airplane gets lower…the angle of attack of the wing must be higher for the wing to produce the lift required to support the weight of the airplane…The same thing happens during rotor stall with a helicopter except it occurs due to low rotor RPM instead of low airspeed. As the RPM of the rotor gets lower, the angle of attack of the rotor blades must be higher to generate the lift required to support the weight of the helicopter…Even if the collective is not raised by the pilot to provide the higher blade angle, the helicopter will start to descend until the upward movement of air to the rotor provides the necessary increase in blade angle of attack…The increased drag on the blades acts like a huge rotor brake causing the rotor RPM to rapidly decrease, further increasing the rotor stall. As the helicopter begins to fall, the upward rushing air continues to increase the angle of attack on the slowly-rotating blades, making recovery virtually impossible, even with full down collective."

FAA publication P-8740-71, "Planning Autorotations,"was intended to raise flight instructor awareness to the hazards of training students in autorotations and provide guidelines and parameters for conducting practice autorotations. The pamphlet concluded, "The number one error in practice autorotations is the failure of the flight instructor to take control of the aircraft and terminate the maneuver before it progresses to a point where the flight instructor is not capable of recovering the aircraft in time to prevent damage to the aircraft or injury to personnel. REMEMBER: As a flight instructor, you are the most knowledgeable and experienced person in that helicopter. Do not let your student fly the helicopter into some corner of its performance envelope where it is not recoverable."