



AVIATION



HIGHWAY



MARINE



RAILROAD



PIPELINE

Aviation Investigation Final Report

Location:	Abingdon, Virginia	Accident Number:	ERA12FA527
Date & Time:	August 24, 2012, 22:30 Local	Registration:	N407N
Aircraft:	Bell 407	Aircraft Damage:	Substantial
Defining Event:	Controlled flight into terr/obj (CFIT)	Injuries:	1 Fatal
Flight Conducted Under:	Part 91: General aviation - Personal		

Analysis

The pilot was transporting passengers across a lake and home from a race track at night. A witness who was boating on the lake across from the helicopter landing area watched the helicopter approach and land. He stated that the landing light was on during the landing. He watched the passengers exit the helicopter and then the helicopter lift off and turn toward the lake, descend down an embankment, and turn over the lake. The witness stated that the landing light was not on during the departure. The helicopter traveled about 150 yards when the bottom skids began to make the water spray. The helicopter then nosed over and impacted the water. The witness then directed his boat toward the impact area where he found the tail boom separated from the fuselage and the cockpit area submerged.

Examination of the fuselage, including the top Plexiglas window and frame, revealed evidence of main rotor contact. The helicopter's engine was torn from the fuselage and could not be located due to poor visibility in the water and its irregular bottom features. The engine control unit (ECU) was retrieved, and all of the data revealed that no engine operating exceedances occurred before impact, and no accumulated engine faults were recorded during the previous engine run. The ECU data and physical evidence are consistent with power being supplied to the main rotor at the moment of impact.

Security camera video footage revealed that the pilot had successfully conducted this low-level, rapid acceleration takeoff profile several times during the day when visual spatial references were plentiful. The available data and evidence, as well as the previous flights, are consistent with controlled flight into water while conducting a rapidly accelerating, low-altitude flight after takeoff over an unlit body of water in dark night conditions. The pilot's decision to attempt a such a takeoff at night without the aid of ambient light or the use of helicopter lights denied him the visual spatial references needed to assure safe terrain and obstacle avoidance. Additionally, the conditions during the flight were conducive to a type of pilot spatial disorientation known as "somatogravic illusion," in which aircraft acceleration may be misinterpreted by the pilot as an increasing nose-up pitch attitude and result in inappropriate nose-down control inputs.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:

The pilot's improper decision to make a low-level departure over water in dark night conditions without lights, which resulted in controlled flight into the water. Contributing to the accident was the pilot's likely spatial disorientation due to a vestibular illusion caused by the rapid acceleration during takeoff.

Findings

Personnel issues	Spatial disorientation - Pilot
Personnel issues	Decision making/judgment - Pilot
Aircraft	Altitude - Not attained/maintained
Environmental issues	Dark - Contributed to outcome
Personnel issues	Use of equip/system - Pilot

Factual Information

History of Flight

Takeoff	Collision during takeoff/land
Maneuvering	Controlled flight into terr/obj (CFIT) (Defining event)

HISTORY OF FLIGHT

On August 24, 2012, about 2230 eastern daylight time, a Bell 407 helicopter, N407N, collided into South Holston Lake during a night departure from a river bank in Abingdon, Virginia. The airline transport pilot was fatally injured. The helicopter was substantially damaged when it impacted the water. The helicopter was registered to and operated by K-VA-T&W-L Aviation LLC under the provisions of 14 Code of Federal Regulations Part 91 as a personal flight. Visual night meteorological conditions prevailed, and no flight plan was filed. The flight was originating from a private field at the time of the accident.

According to a witness, while boating on the lake across from the helicopter landing zone, he watched as the helicopter came in and landed. He recalled that the landing light was on, and he watched as the passengers exited the helicopter. The helicopter then lifted and turned toward the lake, descended down an embankment and made a turn over the lake. The witness said that he noticed that the landing light was not on during the departure flight. The helicopter traveled approximately 150 yards when the bottom skids began to make the water spray on the side of the helicopter. The helicopter then nosed over and made a loud splash. The witness waited for a short moment and then turned on his spot light and moved towards the position of the helicopter. As he moved towards the helicopter, his boat bumped into the tail boom, which was floating away from the fuselage. He continued towards the helicopter and came upon the helicopter floating upside down with the skids upright approximately 2 feet above the water. The witness shined his light throughout the cabin and cockpit but did not see anyone.

PERSONNEL INFORMATION

The pilot, age 64, held an airline transport pilot certificate for airplane single-engine land, multi-engine land, and rotorcraft-helicopter issued May 27, 2008, and a second-class airman medical certificate issued February 17, 2012, with limitations for corrective lenses. The pilot's logbook was not recovered for review. According to the Federal Aviation Administration (FAA) records, the pilot reported 26,000 flight hours on his last medical.

A review of the pilot's flight schedule for that day revealed that the pilot started the passenger flights at 1500 on the day of the accident. A review of the flight schedule times revealed that 10 passenger flights between Bristol Speedway to a private residence near South Holston Lake were made in a period of 1 hour and 20 minutes. After the pilot returned, he was informed that the next flight would start at 2100. During the flights, the pilot hot fueled at the landing site adjacent to the residence where he dropped off and picked up passengers. There is no record of the amount of fuel taken onboard the helicopter during

the day. According to the wife of the pilot, he was well rested the night before and there was nothing abnormal about the day. She went on to say that the pilot was in good health.

AIRCRAFT INFORMATION

The seven-seat, skid equipped helicopter, serial number 53077, was manufactured in 1996. It was powered by a Rolls-Royce model 250-C47B turbo-shaft 650-hp engine.

Review of copies of maintenance logbook records showed an annual inspection was completed March 20, 2012, at a recorded airframe total time of 2,339.1 hours, and an engine time of 2,091.0 hours. The Hobbs hour-meter showed 2,427.8 hours at the accident site. The engine control unit recorded an engine total time of 2,771.06.

Video footage from a security camera captured several daytime departures by the pilot earlier that day. In all the takeoffs, the helicopter was low enough to the surface of the lake to allow the main rotor to create a wake on the surface of the water. On the night of the accident, video footage showed the helicopter's anti-collision lights reflecting off of the lake's surface prior to the accident.

AERODROME INFORMATION

The intended landing site was in the backyard at the private residence of the owner of the helicopter, which is an area of turf grass. The landing site was elevated approximately 30 feet above the lake surface. The area is unlit and not a dedicated helipad and it was used frequently by the owner for helicopter operations.

METEOROLOGICAL INFORMATION

A review of recorded data from the Virginia Highlands Airport, Abingdon, Virginia (VJI) automated weather observation station, elevation 2,087 feet, revealed that at 2235, conditions were wind 100 degrees at 4 knots, visibility of 10 miles, cloud conditions scattered at 11,000 feet above ground level (agl).

On the day of the accident, official sunset was at 2007, end of civil twilight was at 2033, moonset was at 1917 with an elevation more than 29 degrees below the horizon, and moonrise would be 1519 on August 25, 2012. Moon phase was a waxing crescent with 51% of visible disk illuminated. The evening trip took place under nighttime VFR conditions.

WRECKAGE AND IMPACT INFORMATION

The fuselage of the helicopter was recovered on August 28, 2012, approximately 100 yards from the estimated location of the helicopter's original impact point on the water. The helicopter's engine was torn from the fuselage and could not be located due to poor visibility in the water and the irregular bottom features which rendered the search ineffective.

Examination of the cockpit area of the fuselage revealed that it had been breached during impact. The pilot and copilot's seat pans were broken away from their respective bases and deformed. The instrument panel was dislodged from its mount and held to the fuselage by wiring. A cursory examination of the instrument panel revealed that the landing light switch was found in the "both" position but the landing

light circuit breaker was observed in the "out" position (turned off). Examination of the fuselage exhibited evidence of main rotor contact. The top Plexiglas window and frame exhibited evidence of main rotor contact.

Examination of the flight controls revealed that all controls from the collective and cyclic to the vertical control tubes to the hydraulic actuators to the swash plate were intact and no notable damage was observed. The forward vertical firewall exhibited rotational witness marks from the engine to transmission shaft. Rotational witness marks were also present on the transmission shaft. The forward end of the transmission shaft remained attached to the main transmission; the K-Flex coupling on the aft end of the transmission shaft had failed in overload and was splayed outward. The main rotor mast had fractured in overload at its base but had not separated. Examination of the main transmission chip detector upper and lower was found clean of debris. The hydraulic reservoir was found full of hydraulic fluid and clean of debris.

Examination of the main rotor blades revealed that all four rotor blades were fractured consistent with a sudden stoppage. The blue, red, and green pitch change links were bent; the orange pitch change link was fractured in overload. All pitch link hardware was present, and all cotter keys were installed.

The tail boom was fractured at the aft bulkhead and the fracture surfaces were consistent with a main rotor strike. Strike marks were present on both of the top of the vertical stabilizers above the tail boom and the bottom of the vertical stabilizers below the tail boom. The forward-most 4 feet of the tail boom was not recovered. The vertical fin was not damaged, and the anti-collision light remained intact. The tail boom drive shaft was fractured at the number 3 coupling. Examination of the 90-degree gearbox revealed that the chip detector was found clean and free of debris. The 90-degree gearbox rotated with no binding or grinding. Control continuity was confirmed from the forward fracture to the tail rotor control lever upper end. The tail rotor control lever attachment point showed signs of impact damage and remnants of the arm bearing were located in the lower end of the tail cone. No anomalies were found with the tail rotor which would have prevented normal operation and control.

The engine bay showed evidence of contact by the main rotor. The mounts, engine controls, fuel, oil and electrical connections were all severed from the helicopter. The only engine components present were the Engine Control Unit (ECU), part of a throttle control arm, and a small fragment of the starter/generator mount. All engine mounts were fractured in overload and deformed. The engine oil reservoir, oil cooler, and fan were missing.

Due to extensive impact damage, control continuity could not be established from the cockpit to the engine bay. The collective was fractured at its base. The throttle twist grip was deformed and not movable by hand. The throttle was found in the full-open (fly) position. A piece of the throttle engine's throttle arm was present in the engine bay, still attached to a deformed section of throttle control linkage. The airframe-mounted fuel filter was present. The outlet fuel line to the engine had been severed, allowing water contamination of the filter bowl. The filter bowl was opened and examined. A small amount of silt was present, from the river bed but the filter was otherwise normal. The ECU baseplate was deformed due to impact damage.

MEDICAL AND PATHOLOGICAL INFORMATION

An autopsy was performed on the pilot on August 28, 2012, by the Department of Health, Office of the Chief Medical Examiner, Roanoke, Virginia, as authorized by the medical examiner for Washington County.

The FAA's Civil Aerospace Medical Institute performed forensic toxicology on specimens from the pilot with negative results for drugs and alcohol.

TEST AND RESEARCH

Examination of the recorded ECU data revealed that there were no engine operating exceedance prior to impact, and no accumulated engine faults were recorded during the previous engine run. No Incident recorder (IR) data had been written to file; however, a partial Snapshot trigger dataset had been recorded. The Snapshot trigger was caused by an Engine Torque Exceedance of 116%. Only seven sequential engine parameters were recorded in the Snapshot data. This is consistent with destruction of the helicopter occurring almost immediately after the initial over-torque event occurred. Electrical power was lost to the ECU before a full line of Snapshot data could be written or any IR data could be recorded.

Due to the limited amount of data recorded on the ECU, very little analysis of engine performance could be achieved. The disparity between main rotor rpm (Nr) and power turbine speed (Np) is attributable to the rapid deceleration of the main rotor as it impacted the water. There is a 24 millisecond cycle time for the data write; however, the Nr signal first passes through a digital converter before the Np signal. During a rapid deceleration of the main rotor, the recorded value for Np will be lower than that recorded for Nr. The recorded Nr data was sampled a few milliseconds before the recorded Np data. The Np data was recorded during or immediately following the main rotor strike of the water.

ADDITIONAL INFORMATION

Spatial Disorientation

According to Spatial Disorientation in Aviation (F.H. Previc and W.R. Ercoline), the otoliths (tiny organs of the inner ear), sense the acceleration of gravity and the acceleration associated with translational motions. Because the otoliths cannot distinguish between these two types of acceleration, they can only sense a combination of these two forces, the gravito-inertial force (GIF) vector. During coordinated, unaccelerated flight, the GIF vector is directed straight down through the pilot's seat. When an aircraft accelerates rapidly, however, the GIF vector is displaced aft, causing a false sensation of pitching up. This misperception, known as the somatogravic illusion, is normally dispelled when the pilot views the external horizon and/or the flight instruments. If no external horizon is visible and the flight instruments are not continuously monitored or are not correctly interpreted, the somatogravic illusion can persist, leading to an inaccurate understanding of aircraft orientation and direction of motion known as spatial disorientation, a condition that can lead to inappropriate pilot control inputs.

Spatial disorientation illusions are described extensively in FAA pilot training literature. For example, the 2012 Aeronautical Information Manual states, "A rapid acceleration during takeoff can create the illusion of being in a nose up attitude." Similarly, the FAA Instrument Flying Handbook states, "A rapid acceleration, such as experienced during takeoff, stimulates the otolith organs in the same way as tilting the head backwards. This action creates the somatogravic illusion of being in a nose-up attitude, especially in situations without good visual references." The Manual and the Handbook warn that, "The

disoriented pilot may push the aircraft into a nose-low or dive attitude." Identical information is included in the FAA's Pilot Handbook of Aeronautical Knowledge. This particular illusion is so well recognized that information about it is included in the FAA's private pilot, instrument rating, and airline transport pilot knowledge test guides and the FAA practical test standards for private pilots.

According to FAA Advisory Circular AC 60-4A, "Pilot's Spatial Disorientation," tests conducted with qualified instrument pilots indicated that it can take as long as 35 seconds to establish full control by instruments after a loss of visual reference of the earth's surface. AC 60-4A further states that surface references and the natural horizon may become obscured even though visibility may be above VFR minimums, and that an inability to perceive the natural horizon or surface references is common during flights over water, at night, in sparsely populated areas, and in low-visibility conditions.

Pilot Information

Certificate:	Airline transport; Flight instructor	Age:	64
Airplane Rating(s):	Single-engine land; Multi-engine land	Seat Occupied:	Right
Other Aircraft Rating(s):	Helicopter	Restraint Used:	Unknown
Instrument Rating(s):	Airplane; Helicopter	Second Pilot Present:	No
Instructor Rating(s):	Instrument airplane	Toxicology Performed:	Yes
Medical Certification:	Class 2 With waivers/limitations	Last FAA Medical Exam:	February 17, 2012
Occupational Pilot:	Yes	Last Flight Review or Equivalent:	
Flight Time:	(Estimated) 26000 hours (Total, all aircraft), 760 hours (Total, this make and model)		

Aircraft and Owner/Operator Information

Aircraft Make:	Bell	Registration:	N407N
Model/Series:	407	Aircraft Category:	Helicopter
Year of Manufacture:		Amateur Built:	
Airworthiness Certificate:	Normal	Serial Number:	53077
Landing Gear Type:	N/A; Skid	Seats:	7
Date/Type of Last Inspection:	June 19, 2012 100 hour	Certified Max Gross Wt.:	6000 lbs
Time Since Last Inspection:	118 Hrs	Engines:	1 Turbo shaft
Airframe Total Time:	2309 Hrs as of last inspection	Engine Manufacturer:	Rolls-Royce
ELT:	C91 installed, not activated	Engine Model/Series:	250
Registered Owner:	K-VA-T & W-L AVIATION LLC	Rated Power:	650 Horsepower
Operator:	K-VA-T & W-L AVIATION LLC	Operating Certificate(s) Held:	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	Condition of Light:	Night/dark
Observation Facility, Elevation:	VJI, 2087 ft msl	Distance from Accident Site:	5 Nautical Miles
Observation Time:	10:35 Local	Direction from Accident Site:	180°
Lowest Cloud Condition:	Scattered / 11000 ft AGL	Visibility	10 miles
Lowest Ceiling:	None	Visibility (RVR):	
Wind Speed/Gusts:	4 knots /	Turbulence Type Forecast/Actual:	/
Wind Direction:	100°	Turbulence Severity Forecast/Actual:	/ N/A
Altimeter Setting:	30.19 inches Hg	Temperature/Dew Point:	19°C / 17°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Abingdon, VA	Type of Flight Plan Filed:	None
Destination:	Abingdon, VA	Type of Clearance:	None
Departure Time:	10:25 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:	36.594444,-82.018333(est)

Administrative Information

Investigator In Charge (IIC):	Alleyne, Eric
Additional Participating Persons:	Mindy A Graham; FAA/FSDO; Charleston, WV Harold R Barrentine; Bell Helicopter; Fort Worth, TX Jack Johnson; Rolls-Royce; Indianapolis, IN
Original Publish Date:	May 8, 2014
Last Revision Date:	
Investigation Class:	Class
Note:	
Investigation Docket:	https://data.nts.gov/Docket?ProjectID=84792

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