Aviation Investigation Final Report

Location:	Somerville, Tennessee	**Accident Number:**	ERA14FA010
Date & Time:	October 22, 2013, 06:05 Local	**Registration:**	N353HW
Aircraft:	Eurocopter AS 350 B3	**Aircraft Damage:**	Destroyed
Defining Event:	VFR encounter with IMC	**Injuries:**	3 Fatal
Flight Conducted Under:	Part 91: General aviation - Positioning		

Analysis

The flight was dispatched to pick up a patient at a hospital and transport him to another hospital near the helicopter's home base. The pilot performed a weather check, and the flight departed with two medical staff on board. Night, visual meteorological conditions prevailed at the departure helipad. Satellite tracking data revealed that the helicopter proceeded in an easterly direction, following a US highway. The helicopter then climbed in right-hand turn until the satellite data ended; the helicopter was about 1,116 feet above ground level (agl). The wreckage was found, burning, in a wooded area, about 3,300 feet south of the US highway. No eyewitnesses to the accident were located. The helicopter impacted the trees at a steep angle, and the orientation of the main wreckage was indicative of a loss of helicopter control before impact. The wreckage was largely consumed by a postcrash fire.

Examination of the airframe, rotor system, and engine did not reveal evidence of a preexisting mechanical malfunction of failure. Rotational signatures on the main rotor and engine indicated that the engine was producing power at the time of the accident.

The helicopter was equipped with night vision goggles (NVG) and NVG-capable lighting. The pilot had been trained on the use of NVG about 12 months before the accident. The helicopter was not equipped for flight under instrument flight rules.

A review of the weather conditions revealed that, at an airport within 2 miles of the accident site, few clouds were observed at 800 feet agl, and a broken ceiling existed at 1,200 feet agl. A review of the helicopter's ground track revealed two obstacles in the immediate vicinity, an unlit, nonoperational cellular tower, 140-feet tall, and a water tower, about 115-feet tall. The helicopter was equipped with a Helicopter Terrain Avoidance Warning System (HTAWS). Although recorded HTAWS data was not available, research and flight testing revealed that the pilot may have received an in-flight obstacle alert, prompting a climb. Considering the low clouds and night conditions that probably existed along the last segment of the flight's track, it is likely that the pilot initiated a climb and inadvertently entered instrument meteorological conditions, where a loss of helicopter control occurred.

Probable Cause and Findings

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

The pilot's inadvertent encounter with night, instrument meteorological conditions while responding to an obstacle alert, resulting in an in-flight loss of helicopter control.

Findings

Aircraft	(general) - Not attained/maintained
Personnel issues	Incorrect action performance - Pilot
Environmental issues	Dark - Effect on operation
Environmental issues	Low ceiling - Effect on operation

Factual Information

History of Flight

Enroute-cruise	Abrupt maneuver
Maneuvering	VFR encounter with IMC (Defining event)
Maneuvering	Loss of control in flight
Uncontrolled descent	Collision with terr/obj (non-CFIT)

HISTORY OF FLIGHT

On October 22, 2013, about 0605 central daylight time (CDT), a Eurocopter AS 350 B3, N353HW, impacted trees and terrain near Somerville, Tennessee. The certificated commercial pilot, a registered nurse, and a respiratory therapist were fatally injured; the helicopter was destroyed by impact forces and a post-crash fire. The helicopter was registered to and operated by Memphis Medical Center Air Ambulance Service, doing business as Hospital Wing, under the provisions of 14 Code of Federal Regulations Part 91, as a positioning flight. The flight operated on a company visual flight rules flight plan. The flight originated from Hospital Wing Heliport (2TN0), Memphis, Tennessee, at 0547 and was en route to Whitehurst Field Heliport (60TN), Bolivar, Tennessee.

According to company personnel, the accident pilot arrived for work about 1730 on October 21 and began his flight planning procedures, which included a review of the local area weather and completion of the company's risk assessment checklist. About 0025 on October 22, a call came in to company, requesting helicopter services to Piperton, Tennessee to pick up a patient. The pilot completed a weather check at 0026 and the flight departed 2TN0 at 0035. About two minutes later, the pilot aborted the flight and returned to 2TN0 due to low ceilings. The flight was cancelled due to weather.

At 0137, another call was received by the company for helicopter services in Olive Branch, Mississippi. The accident pilot declined the flight due to weather.

At 0500, another request for helicopter services was received by the company, to pick up a patient at 60TN and transport him to Memphis. Dispatch records indicated that the accident pilot performed a weather check at 0500 and the flight was dispatched at 0503. According to satellite tracking data provided by the operator, the helicopter departed 2TN0 at 0547 and proceeded in an easterly direction, following U.S. Highway 64. About 18 minutes later, the helicopter was observed in a climb and in a right turn away from the observed course. The last data point indicated that the helicopter was on a course of 146 degrees and at 98 knots ground speed and at an altitude of 1,560 feet above mean sea level (msl) or about 1,116 feet above ground level (agl).

The operator dispatched two aircraft to the last known position of N353HW after the pilot did not make the normal 10-minute position report. One of the pilots observed a fire in a rural area about 19 miles west of 60TN. First responders confirmed that the helicopter had crashed at that location.

Several local residents were interviewed after the accident. They reported hearing a helicopter in their vicinity near the time of the accident; however, no one reported hearing the helicopter crash. Also, no eyewitnesses to the accident were found. Their statements are included in the public docket for this accident investigation.

PERSONNEL INFORMATION

The pilot, age 47, held a commercial pilot certificate with ratings for rotorcraft-helicopter, instrument-helicopter, and airplane single engine land. According to the operator, his total flight experience was 2,441 hours, including 521 hours in the accident helicopter make and model, and 2,250 hours in rotorcraft. His flight experience during the 90 days prior to the accident was 33 hours, including 10 hours in the 30 days prior to the accident.

According to the operator, the pilot flew previously with the Memphis Police Department (MPD), where he accumulated about 400 hours in the AS 350. He received all of his night vision goggle (NVG) training and experience at Hospital Wing, since MPD did to utilize NVG.

Training records provided by the operator revealed that the pilot completed AS 350 B3 initial training (ground and flight) on October 31, 2012. Ground training consisted of 51 hours and flight training consisted on 12.1 hours, including 5.8 hours with NVG. The training was conducted "in house" by the Hospital Wing Chief Pilot. The training included inadvertent instrument meteorological conditions (IMC) scenarios in a simulator.

Several company pilots, supervisors, and nurses were interviewed following the accident. In general, the accident pilot was described as a good pilot, well-liked by the other company pilots and medical staff, and conscientious. He flew "by the book," did not "press" the weather, and utilized the company's risk assessment tools.

AIRCRAFT INFORMATION

The accident helicopter was a Eurocopter AS350 B3 model that was manufactured in 2001. It was equipped with a three-blade main rotor system and a two-blade tail rotor system and was powered by a Turbomeca Arriel 2B engine rated at 871 shaft horsepower. The helicopter was purchased new by the operator.

The helicopter was equipped with skid-type landing gear, NVG and NVG-compatible lighting, an Aspen Avionics 1000H primary flight display/multi-function display (PFD/MFD), a vehicle engine multifunction display (VEMD), an autopilot, an enhanced ground proximity warning system (EGPWS), and a Thales/Sextant Digital Electronic Control Unit (DECU). The helicopter was not equipped for flight under instrument flight rules.

According to the operator, the helicopter was maintained under the manufacturer's inspection program. The last recorded aircraft time was 6,391.1 hours on October 13, 2013. The most recent aircraft inspection occurred on October 11, 2013, which was a 30-hour inspection. The last annual inspection occurred on July 17, 2013, at 6,274.3 hours.

METEOROLOGICAL INFORMATION

The closest weather observation facility to the accident site was Fayette County Airport (FYE), located about 1.5 nautical miles (nm) south-southwest of the accident site. The airport elevation was about 436 feet msl. The 0556 surface weather observation (about 9 minutes prior to the accident) included a broken ceiling at 1,600 feet agl, wind from 030 degrees at 4 knots, visibility 10 statute miles or greater, temperature 11 degrees C, dew point minus 1 degrees C, and altimeter setting 30.05 inches of mercury.

The FYE observation about 2 minutes after the accident, at 0607, included calm wind, few clouds at 800 feet agl, a broken ceiling at 1,200 feet agl, a broken ceiling at 6,000 feet agl, visibility 10 statute miles or greater, temperature 11 degrees C, dew point minus 1 degrees C, and altimeter setting 30.05 inches of mercury.

The Memphis International Airport (MEM) observation (5 nm SE of 2TN0), at 0554 (about 3 minutes prior to takeoff) included wind from 010 at 7 knots, few clouds at 1,200 feet agl, scattered clouds at 4,700 feet agl, overcast ceiling at 5,500 feet agl, and visibility 10 statute miles or greater.

Official sunrise at Somerville, on October 22, 2013 was about 0710 and civil twilight was about 0644.

WRECKAGE AND IMPACT INFORMATION

The aircraft wreckage debris was located in a wooded area surrounded by cotton and soybean fields, approximately 3,300 feet south of U.S. Highway 64, in Somerville. The accident site elevation was about 372 feet. The majority of the aircraft structure, including the cockpit, instruments and controls, was burned and consumed by impact forces and a post-impact fire. The VEMD exhibited extensive thermal damage during the post-crash fire and further examination was not attempted. The helicopter impacted trees prior to impacting the ground. The energy path was generally oriented on a magnetic heading of about 090 degrees and was about 100 feet in length. The flight path angle, measured from broken trees to the initial impact crater, was about 50 degrees. All static and dynamic components of the helicopter were accounted for at the accident site.

All three main rotor blades exhibited signatures consistent with powered impact strikes throughout the length of the blades. The red and yellow blades showed more extensive damage, where impact forces resulted in blade delamination. Severe fraying was also observed at the outboard tips of all three blades.

The tail boom was consumed by a post-impact fire and the horizontal stabilizers exhibited both thermal and impact damage. The vertical stabilizer and vertical fin were consumed by fire. The engine output-to-tail rotor drive shaft flange remained bolted to the engine; however, all three flange tangs that attached to the flex couplings were bent and pulled aft and separated at the flex coupling. The splined coupling remained attached to the flex coupling on the tail rotor forward steel drive shaft. The splined portion on the tail rotor drive shaft was separated with no visible anomalies to the splines. The length of the tail rotor drive shaft was bent in a "u" shape, approximately mid-span from impact forces and was broken just aft of the third hanger support bearing. The aft section of the drive shaft was separated and partially damaged from post impact fire and was separated at the aft flexible coupling flange. The aft flange mount was thermally separated from the tail rotor drive shaft; the flexible couplings were intact to the coupling system but broken away from the tail rotor gearbox forward mounts.

Both tail rotor blades remained attached to the tail rotor gearbox; there was no visible impact damage observed to the leading edges; however, both blades exhibited thermal decomposition. The hub could not be pulled off the shaft due to thermal damage; however, the woodruff key appeared to be in place

when the nut was removed. The gearbox oil cap was melted away and the oil was consumed. Subsequent disassembly of the tail rotor gearbox revealed no anomalies except for post-crash fire signatures. No metallic debris was observed on the chip detector. The yaw load compensator was observed to be thermally damaged and separated from the helicopter and was found within the main wreckage area.

Flight control continuity could not be confirmed due to post-crash fire damage. The cyclic, collective, and anti-torque pedals were found lying loose in the cockpit area of the fire-consumed main wreckage.

The helicopter's fuel system was consumed by fire and no on-site documentation of fuel status could be performed; however, the operator reported that the helicopter departed 2TN0 with 101 gallons of fuel on board.

The remaining components of the hydraulic system were examined by the investigation team. When the hydraulic pump pulley wheel was turned by hand, a residual amount of clean-looking red hydraulic fluid was jettisoned. The pump was disassembled; the pulley wheel spline (female) and the pump spline (male) were intact. The pump gears appeared clean and operational. All of the hydraulic lines were consumed in the post-crash fire; except for the partial line segments still attached to the fore/aft servo. The servos from the transmission were examined; each of the servos exhibited various degrees of fire and impact damage. The left and right main rotor servo accumulators were empty, or near depleted (the left servo emitted a small, but notable, amount of gas when the Schrader valve was depressed). The fore/aft accumulator had considerably more gas pressure when the Schrader valve was depressed. And, it was also noted that the top cylinder was separated in overload from the housing body at its attachment bolts. Similarly, the spine on the right servo housing body exhibited a crack along the length of its body.

Both landing gear skids and cross tubes were fractured in multiple locations. The aft half of the fractured left landing gear skid was lodged into the ground vertically and could not be removed by hand, with the aft end of the section under the soil. A forward section of the right skid, about 2 feet in length, was broken open and tree matter was found lodged inside the tube.

The engine was found lying on its left side and covered by the burnt remains of the engine cowling. The hydro-mechanical unit (HMU) was separated from the accessory gearbox and was held in place by fuel piping. The oil and fuel lines were burnt from the post-crash fire; however, all appeared properly attached and safety wired. The axial compressor blades were all bent and broken consistent with a dent at the nine o'clock position of the compressor casing, indicative of gas generator rotation at the time of impact. The gas generator could not be turned by hand. The exhaust pipe was crushed and the free turbine, reduction gearbox, and power shaft/freewheel shaft could not be turned by hand. The left side of the turbine case and linking tube were also crushed, indicating impact with the ground on the left side.

The wreckage was recovered to a storage facility where a partial engine teardown was performed. The exhaust duct was cut off with a plasma torch, revealing that the free turbine blades were broken by impact forces with the support struts during the accident sequence, indicative of rotation during impact. The angle and break pattern of the blades were consistent with impact damage. The reduction gearbox was removed for examination of the input pinion alignment marks. The marks were found misaligned in the tightening direction approximately 1 to 1.5mm, which was consistent with power delivery at the time of a main rotor strike. The DECU exhibited extensive thermal damage during the post-crash fire and further examination was not attempted.

MEDICAL AND PATHOLOGICAL INFORMATION

A postmortem examination of the pilot was performed at the offices of the Chief Medical Examiner, West Tennessee Regional Forensic Center, Memphis, Tennessee on October 23, 2013. The autopsy report noted the cause of death as "Multiple blunt force injuries" and the manner of death was "Accident."

Forensic toxicology testing was performed on specimens of the pilot by the Federal Aviation Administration (FAA) Bioaeronautical Sciences Research Laboratory (CAMI), Oklahoma City, Oklahoma. The CAMI toxicology report indicated negative for ethanol and drugs in muscle. Testing for carbon monoxide and cyanide was not performed.

TESTS AND RESEARCH

Test Flight

A review of the accident helicopter's flight path revealed two obstacles within less than a half mile of the accident helicopter's last recorded flight position. These obstacles included a 140-foot-tall, unlit, non-operational cellular tower to the east and a water tower, approximately 115-foot-tall to the west of this position. The obstacles' close proximity to the helicopter's course led to a flight test intended to examine if the helicopter's onboard Helicopter Terrain Avoidance Warning System (HTAWS) may have prompted any alerts during the flight. A flight test was conducted on March 24, 2014, which was flown by a representative of the helicopter operator who was accompanied by representatives from the aircraft manufacturer, FAA, and NTSB. The test helicopter, N857HW, was a Eurocopter AS 350 B3 model and was equipped with similar avionics as the accident helicopter, which included a Garmin G530 global positioning system with HTAWS.

A path spanning about 3 nm was flown nine times at decrementing altitudes. Each pass began over highway 64 about 3 nm west of the accident helicopter's final radar target and ended slightly north of the accident site. The HTAWS generated both obstacle and terrain caution alerts; two alerts for the cellular tower were heard when the test flight flew the path at 300 feet agl and three alerts for the water tower when the test flight flew the path between 350 feet and 400 feet agl. There were no HTAWS alerts issued during flight at the accident helicopter's reported altitudes; however, during the test flight helicopter's descent the HTAWS issued a terrain caution just beyond the second to last radar target. The helicopter's radar altimeter read 300 feet agl when the terrain alert was issued.

Garmin HTAWS

Garmin, the HTAWS developer, conducted a simulation using the accident helicopter's flight data provided by the NTSB. The test apparatus included a GNS530W GPS loaded with software, terrain, and obstacle databases that were valid at the time of the accident.
The purpose of the simulation was to identify obstacle or terrain alerts that may have been issued during the accident flight. The accident helicopter's flight path was flown six times in normal alerting mode and then in reduced protection mode. To simulate potential terrain alerts the system was also programmed to fly the accident helicopter's last five radar targets multiple times while decreasing the altitude of each pass by 100 feet.
During the accident flight the helicopter encountered 100 feet of gradually rising terrain near the second to last radar target. In the simulation, one terrain alert was issued during level flight about 700 feet msl

and was also located near the second to last radar target. According to a representative of Garmin, the system will issue terrain alerts for an aircraft in straight and level flight if the aircraft descends below 400 feet agl. The representative also stated that for descending flight the HTAWS system can issue terrain alerts at higher altitudes with zero vertical speed, but added that the simulator was not setup to replicate vertical paths.

ADDITIONAL INFORMATION

Risk Assessment

Hospital Wing had a formal risk assessment program at the time of the accident. According to Hospital Wing, a risk assessment form was completed at the beginning of the pilot's duty shift. Included with the risk assessment was a crew briefing checklist that included crew names, weather minimums, local weather observations and forecasts, and in-flight communication procedures. Based on interviews with Hospital Wing flight crews and staff, the pilot routinely utilized the risk assessment tool and briefed his medical crew on any risks pertinent to that flight.

The risk assessment form evaluated static risks (such as low pilot experience and inoperative aircraft equipment) and dynamic risks (such as poor weather and lack of night lighting). Each category was given numerical values, which were added to determine a total static and dynamic risk value. Higher risk values indicated increased risk. Points were also subtracted in certain situations (such as high pilot experience and NVG usage). A value greater than 14 resulted in a "no go" situation.

The total static and dynamic risk calculated by the pilot at 1759 on the evening prior to the accident was "11," which included the following risk factors: less than one year experience in emergency medical services, deteriorating weather trend, and night flight.

A copy of the risk assessment form was provided to investigators, which was initialed by the pilot. The pilot entered hand-written notes on the form, indicating "Precipitation" (3 risk points) and "Temp/Dew point within 3 degrees" (3 risk points); however, the time the notes were entered could not be determined. The following notes were also observed, "Updated after Mid" and "After midnite rain."

Pilot Information

Certificate:	Commercial	**Age:**	47
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	4-point
Instrument Rating(s):	Helicopter	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 2 Without waivers/limitations	**Last FAA Medical Exam:**	November 12, 2012
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	October 31, 2012
Flight Time:	2441 hours (Total, all aircraft), 521 hours (Total, this make and model), 33 hours (Last 90 days, all aircraft), 10 hours (Last 30 days, all aircraft), 0 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Eurocopter	**Registration:**	N353HW
Model/Series:	AS 350 B3	**Aircraft Category:**	Helicopter
Year of Manufacture:	2001	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	3401
Landing Gear Type:	N/A; Skid	**Seats:**	4
Date/Type of Last Inspection:	September 24, 2013 100 hour	**Certified Max Gross Wt.:**	4961 lbs
Time Since Last Inspection:		**Engines:**	1 Turbo shaft
Airframe Total Time:	6372 Hrs as of last inspection	**Engine Manufacturer:**	Turbomeca
ELT:	C126 installed	**Engine Model/Series:**	Arriel 2B
Registered Owner:	MEMPHIS MEDICAL CENTER DBA	**Rated Power:**	871 Horsepower
Operator:	MEMPHIS MEDICAL CENTER DBA	**Operating Certificate(s) Held:**	On-demand air taxi (135)
Operator Does Business As:	Hospital Wing	**Operator Designator Code:**	

Meteorological Information and Flight Plan

Conditions at Accident Site:	Unknown	**Condition of Light:**	Night/dark
Observation Facility, Elevation:	FYE,436 ft msl	**Distance from Accident Site:**	1 Nautical Miles
Observation Time:	06:07 Local	**Direction from Accident Site:**	210°
Lowest Cloud Condition:	Few / 800 ft AGL	**Visibility**	10 miles
Lowest Ceiling:	Broken / 1200 ft AGL	**Visibility (RVR):**	
Wind Speed/Gusts:	/	**Turbulence Type Forecast/Actual:**	/ None
Wind Direction:		**Turbulence Severity Forecast/Actual:**	/ N/A
Altimeter Setting:	30.04 inches Hg	**Temperature/Dew Point:**	11°C / -1°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Memphis, TN (2TN0)	**Type of Flight Plan Filed:**	Company VFR
Destination:	Bolivar, TN (60TN)	**Type of Clearance:**	None
Departure Time:	05:47 Local	**Type of Airspace:**	

Wreckage and Impact Information

Crew Injuries:	3 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:		**Aircraft Fire:**	On-ground
Ground Injuries:	N/A	**Aircraft Explosion:**	Unknown
Total Injuries:	3 Fatal	**Latitude, Longitude:**	35.229999,-89.380279

Administrative Information

Investigator In Charge (IIC):	Hicks, Ralph
Additional Participating Persons:	Michael Hemann; FAA Rotorcraft Directorate; Fort Worth David D Hays; FAA/FSDO; Memphis, TN Glen Wilson; Hospital Wing; Memphis, TN Seth D Buttner; American Eurocopter Corporation; Grand Prairie, TX Bryan Larimore; Turbomeca USA; Grand Prairie, TX Nathalie Gilliers; BEA; Paris
Original Publish Date:	January 27, 2015
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=88253