Aviation Investigation Final Report

Location:	Hazelhurst, Wisconsin	**Accident Number:**	CEN18FA149
Date & Time:	April 26, 2018, 22:50 Local	**Registration:**	N127LN
Aircraft:	Eurocopter AS 350 B2	**Aircraft Damage:**	Destroyed
Defining Event:	Loss of control in flight	**Injuries:**	3 Fatal
Flight Conducted Under:	Part 91: General aviation - Positioning		

Analysis

The helicopter pilot and two emergency medical service crewmembers were on a repositioning flight in night visual meteorological conditions after two helicopter air ambulance flights and a refueling stop. The total flight time for the first three flights was 94 minutes and occurred over a period of about 2 ½ hours.

The helicopter departed on the accident flight about 2107. About 1 minute later, the pilot asked the crewmembers whether they were "alright." One crewmember responded "yup" and then asked the pilot, "question is are you alright up there?" The pilot responded, "uhhh think so. Good enough to get us home at least." There was no further discussion related to fatigue. During the flight, the pilot adjusted his seat position and flexed his legs, which were actions consistent with signs of fatigue. Also, although the pilot participated in the medical crewmembers' conversations in the middle of the flight, he did not participate in their conversations near the end of the flight. During the last portion of flight, the helicopter entered a progressively steepening right bank, and the pilot did not respond as the medical crewmembers shouted his name. The helicopter descended and became inverted, and the pilot continued not to respond as the crewmembers' shouted his name.

After the helicopter began to roll to the right, the pilot slumped to the left, appearing incapacitated. There was no evidence indicating that the pilot was suffering from a medical condition that could have caused his incapacitation. There was also no evidence of poor quality or quantity of sleep; the pilot's wife reported no issues with the pilot falling asleep or staying asleep, and cellular telephone records and his wife's interview indicated adequate sleep opportunity in the days preceding the accident. On the day of the accident, cellular telephone activity revealed two possible opportunities for the pilot to sleep before going on duty but it is not known if the pilot rested during those times. Thus, the pilot could have been awake for about 15.5 hours at the time of the accident (based on telephone records showing activity at 0725 the morning of the accident) if he did not take advantage of the sleep opportunities. Although this time since awakening would not be considered excessive, this accident shift was the pilot's first after returning from a week-long vacation during which his circadian rhythm would have had him sleeping.

Further, the environment created by the helicopter vibration, darkness of night, and few operational demands during the cruise phase of flight would have increased the pilot's fatigue and the body's biological desire to sleep. These factors, along with the pilot's movements observed on the image recorder, indicated that the pilot became fatigued during the flight. Thus, he pilot likely fell asleep during the flight as a result of the time of day, his time since awakening, and the fatigue-inducing effect of the 1 ½ hour flight.

No light or audio warnings that would indicate a mechanical malfunction were observed during the accident flight. Postaccident examination and testing revealed no preimpact anomalies that would have precluded normal operation of the helicopter.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The pilot's loss of helicopter control as a result of fatigue during cruise flight at night.

Findings

Personnel issues	Aircraft control - Pilot
Personnel issues	(general) - Pilot
Environmental issues	Dark - Contributed to outcome
Aircraft	(general) - Not attained/maintained

Factual Information

History of Flight

Enroute	Loss of control in flight (Defining event)
Uncontrolled descent	Collision with terr/obj (non-CFIT)

On April 26, 2018, about 2243 central daylight time, a Eurocopter AS350 B2 helicopter, N127LN, was destroyed when it was involved in an accident near Hazelhurst, Wisconsin. The commercial pilot and two emergency medical services crewmembers were fatally injured. The helicopter was operated as a Title 14 *Code of Federal Regulations* Part 91 repositioning flight.

According to the operator, Air Methods Corporation, the pilot and the medical crewmembers transported a patient from the Howard Young Medical Center Heliport (60WI), Woodruff, Wisconsin, to the Merrill Municipal Airport (RRL), Merrill, Wisconsin, departing about 1759 and arriving about 1819. The helicopter then departed from RRL about 1832 with another patient aboard and landed at the UW Hospital and Clinics Heliport (WS27), Madison, Wisconsin, about 1937. The patient was offloaded, and the helicopter departed WS27 about 2028 for refueling at Dane County Regional Airport (MSN), Madison, Wisconsin, arriving about 2037.

About 2104, the pilot radioed the operator to report that the helicopter was ready to depart MSN for 60WI. According to information from the helicopter's on-board Appareo Vision 1000 recorder (which records image, audio, and parametric data), the pilot conducted a preflight of the helicopter with the engine operating, and no anomalies were detected. Yawning and sighs were heard. The pilot requested clearance to 60WI and departed about 2107. About 1 minute later, the pilot asked if the medical crew was "alright back there," and one of the medical crewmembers responded "yup." One of the medical crewmembers then stated, "question is are you alright up there?" The pilot responded, "uhhh think so. Good enough to get us home at least."

About 2200, a medical crewmember stated, "I could go to sleep," and the pilot responded, "yeah that'd be nice huh." About 2205, the pilot made a radio call to Central Wisconsin Airport's radio frequency. Recorded weather information was heard, and the pilot subsequently made a position announcement. After about 2215, the medical crewmembers started non-aviation-related conversations, and the pilot was last heard during the conversations about 2229. Between about 2215 and 2242, the pilot made movements including raising his left arm near his helmet (which was mounted with night vision goggles), flexing his legs, adjusting his seating position, and changing cyclic position.

About 2243, the helicopter was operating in level flight at an airspeed of 126 knots and an altitude of at 2,280 ft mean sea level (msl). The artificial horizon indicator then showed the initiation of a right bank. The pilot's right forearm started moving along with the cyclic to the right, and the artificial horizon indicated a bank between 10° and 15°. The roll rate to the right appeared to increase rapidly, and the pilot's body, right forearm, and right hand (which was holding the base of the cyclic grip) appeared to move along with the increased roll rate.

A medical crewmember stated "what are we doin'?" twice. The pilot's head moved to the right and could no longer be seen in the image, and the right bank increased to more than 90°. A medical crewmember stated, in a strained voice, "Ohhh [expletive]." The crewmember then shouted "what?" and the pilot's name. The other medical crewmember also shouted the pilot's name. The pilot's head returned to the image and moved to the left. His right hand still gripped the cyclic. The artificial horizon showed an inverted indication, and the torque gauge indicated a value beyond the red line. The emergency locator transmitter light illuminated while the pilot's head and upper body moved to the left. Sounds similar to a rotor high rpm horn and a grunt were recorded, along with a medical crewmember shouting the pilot's name. The recording contained no response from the pilot when the crewmembers shouted his name. The artificial horizon indicated a right roll of more than 270° with a pitch-down attitude, the altimeter indicated 1,900 ft msl, and the airspeed indicator showed 98 knots. The last two frames showed that the pilot's head and upper body had moved to the right and that the airspeed indicator displayed 70 knots, the artificial horizon indicated a 90° left bank with a pitch-down attitude, and the altimeter indicated 1,825 ft msl.

The company's satellite tracking of helicopter showed a normal route of flight until contact was lost at 2243. The helicopter wreckage was found about 0215 the next day.

Pilot Information

Certificate:	Commercial	**Age:**	34,Male
Airplane Rating(s):	Single-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	None	**Restraint Used:**	4-point
Instrument Rating(s):	Helicopter	**Second Pilot Present:**	No
Instructor Rating(s):	Helicopter; Instrument helicopter	**Toxicology Performed:**	Yes
Medical Certification:	Class 2 Without waivers/limitations	**Last FAA Medical Exam:**	May 31, 2017
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	
Flight Time:	(Estimated) 3200 hours (Total, all aircraft)		

The accident flight was the pilot's first flight after a week-long family vacation in Florida. According to cellular telephone records and an interview with the pilot's wife, the pilot had a sleep opportunity of more than 9 hours during each of the 6 nights before the accident. On April 25, 2018, the pilot and his family traveled to Milwaukee, Wisconsin, on an early morning airline flight, had lunch in Milwaukee, and then made the 4-hour drive home. The trip from Florida to Wisconsin involved a change in time zones. Cellular telephone records indicated the pilot's activity from 1655 to 2038 with two extended breaks in activity (greater than 60 minutes) from 1658 to 1801 and from 1802 to 2011. The pilot's wife thought that he went to sleep between about 2100 and 2130.

The time that the pilot awoke on the day of the accident was not known. Cellular telephone records indicated his activity from 0725 to 2057 with three extended breaks in activity (greater than 60 minutes) from 0923 to 1118, 1431 to 1556, and 1741 to 2040.The pilot's wife stated that, before going on duty, he would normally rest and sleep during the day, but she did not know if he rested or slept during the day of

the accident. The pilot's wife reported no issues with the pilot falling asleep or staying asleep.

The pilot's wife, who was also a pilot at Air Methods, was on duty on the day of the accident and worked the day shift. She saw her husband when he arrived at work for the night shift and thought that he had arrived about 45 minutes early for his shift. They did the shift change together, and she noted nothing unusual about her husband. .

Aircraft and Owner/Operator Information

Aircraft Make:	Eurocopter	**Registration:**	N127LN
Model/Series:	AS 350 B2 NO SERIES	**Aircraft Category:**	Helicopter
Year of Manufacture:	2006	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	4149
Landing Gear Type:	Skid	**Seats:**	4
Date/Type of Last Inspection:	AAIP	**Certified Max Gross Wt.:**	
Time Since Last Inspection:		**Engines:**	1 Turbo shaft
Airframe Total Time:		**Engine Manufacturer:**	Turbomeca
ELT:	C126 installed, activated, aided in locating accident	**Engine Model/Series:**	1D1
Registered Owner:	AIR METHODS CORP	**Rated Power:**	732 Horsepower
Operator:	AIR METHODS CORP	**Operating Certificate(s) Held:**	On-demand air taxi (135)
Operator Does Business As:		**Operator Designator Code:**	QMLA

The helicopter was configured for helicopter air ambulance services. The helicopter was equipped with a radar altimeter and a Honeywell MK XXI enhanced ground proximity warning system.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Night
Observation Facility, Elevation:	KARV,1630 ft msl	**Distance from Accident Site:**	11 Nautical Miles
Observation Time:	22:55 Local	**Direction from Accident Site:**	352°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	/	**Turbulence Type Forecast/Actual:**	/
Wind Direction:		**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.87 inches Hg	**Temperature/Dew Point:**	0°C / -1°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	MADISON, WI (MSN)	**Type of Flight Plan Filed:**	Company VFR
Destination:	WOODRUFF, WI (60WI)	**Type of Clearance:**	None
Departure Time:	21:04 Local	**Type of Airspace:**	

According to US Naval Observatory sun and moon data, the end of civil twilight in the Rhinelander, Wisconsin, area, 17 nm southwest of the accident site, on the day of the accident was 2031, and moonset was at 0507 the next day. The phase of the moon on the day of the accident was a waxing gibbous with 88% of the moon's visible disk illuminated.

Wreckage and Impact Information

Crew Injuries:	3 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	3 Fatal	**Latitude, Longitude:**	45.754444,-89.695831

The helicopter was found in a wooded area about 178° and 8.4 nautical miles from 60WI. The wreckage exhibited no signs of fire. A 70-ft-tall tree that was located about 66° and 47 ft from the nose of the wreckage had broken branches. Other trees between that tree and the wreckage had trunks and branches that were broken and linearly separated. A ground impression that was about 11 ft long, 9 ft wide, and 2 ft deep was found in front of the helicopter wreckage. The helicopter came to rest on its right side. The heading of the wreckage from the tail to the nose was about 095°. The smell of fuel was present at the site and in the ground below the helicopter. All major components of the helicopter were located at the site. The cockpit and cabin area was destroyed. The fuselage exhibited rearward crushing deformation.

The tailboom was attached to the fuselage. The tail rotor gear box and tail rotor blades remained on the tail. The vertical fin had partially detached from the end of the tailboom. Both horizontal stabilizers were present on the tail. All three rotor blades remained attached to the rotor hub, which was attached to the transmission. The main rotor blades exhibited damage that includes spar fractures and leading edge abrasions and depressions. The main rotor hub rotated when the transmission input drive shaft was manually rotated. The fuel tank was fragmented. Yaw, pitch, lateral, and collective controls were traced from the cockpit to their respective servo actuators. Engine controls were traced from the cockpit through their respective bellcranks to their engine components. A magnetic plug in the hydraulic system had some particulate on its magnetic end. The filter bypass button on the hydraulic control block was popped.

The hydraulic pump exhibited a suction and pressure at the pump's inlet and outlet. Disassembly of the hydraulic pump revealed scoring witness marks on the pump housing in its gear's plane of rotation, and no debris or obstructions were observed within the pump ports. Computed tomography images of the three main rotor actuators, showed some internal anomalies with the pitch actuator, including the presence of an unknown material next to the extend side end cap of the actuator and material consistent with the piston head seal in the extend side cavity of the actuator. The images shows no indications of internal anomalies in the left lateral and right lateral main rotor actuators, and tail rotor yaw actuators. The hydraulic pump and four actuators were subsequently examined by their manufacturers Visual examination of the components of the pump showed no abnormal indications, obvious wear, or defects, and the seals were in good condition. The pump was reassembled and tested, and the pump met the specifications for a new pump. Examination of the three main rotor actuators and the tail rotor actuator revealed that the damage they sustained was consistent with impact damage. No preimpact damage was found.

The engine was found on the ground separated from the fuselage. The engine compressor blades exhibited nick and gouge damage consistent with foreign object ingestion. The power turbine blades exhibited silver-colored deposits. The power turbine was manually turned, but the drive train did not turn. Subsequent examination revealed that the engine's module 5 reduction gearbox had migrated rearward out of its installed position with its O-ring groove visible. The module 5 gearbox was removed for inspection of the input pinion torque alignment marks. The marks were found to be misaligned about 0.08 inch in the tightening direction, which is consistent with engine power being delivered to the drive train during the accident sequence.

The Appareo unit was found near the cockpit area. The download of the data found no light or audio warnings that would indicate a mechanical malfunction. Additionally, there was no recorded evidence of a bird strike.

Medical and Pathological Information

The University of Wisconsin Anatomic Pathology Laboratory performed an autopsy of the pilot. His cause of death was multiple traumatic injuries. Toxicology testing performed at the Federal Aviation Administration (FAA) Forensic Sciences Laboratory was negative for ethanol

and tested-for substances.

Tests and Research

Video Camera Analysis

At the request of the NTSB, the Bureau d'Enquêtes et d'Analyses pour la Sécurité de l'Aviation Civile analyzed video from two cameras (located in parking lots near the accident site) that recorded the sounds of the helicopter during flight and the accident sequence. The spectral analysis showed that the acoustic signature of both the main and the tail rotors seemed to be nominal until the end of the recording. Engine condition and speed could not be determined.

A sudden decrease of the frequencies was detected 7.5 seconds before the end of the flight. The decrease was most likely due to a heading change and was followed by a slight reduction of the rotor speed. About 3.5 seconds before impact, the helicopter's rotor speed sharply increased, reaching in 2.5 seconds the average value of 125% rotor system speed.

Performance Study

A performance study for this accident was conducted using the recorded Appareo data. The study showed that, during the accident flight, the helicopter averaged groundspeeds between 90 and 115 knots and flew at altitudes between 800 and 1,100 ft above ground level. By 2240, the helicopter was about 1,300 ft above ground level, but the increase in altitude coincided with an increase in terrain elevation. At 2243:12, the helicopter's pitch and roll attitude began to increase; by 2243:21, the helicopter was fully inverted. During the last 6 seconds of recorded data (2243:18 to 2243:24), the helicopter began to rapidly lose altitude at a rate of about 5,000 ft per minute.

The accident flight was operated 200 to 600 ft lower and 20 to 40 knots slower than the three previously recorded flights, which were flown by the accident pilot.

Additional Information

The operator's general operations manual defined a scheduled duty period as "12 scheduled consecutive hours that may be extended to 14 hours" and a rest period as "10 scheduled hours of rest that are consecutive, known in advance and free from all restraint." The manual further stated the following:

Pilots and certificate managers are responsible for ensuring compliance with the flight time limitations

and rest requirements. Pilots will report for duty with the appropriate rest and be capable of performing their assigned flight crewmember duties. At any time a flight crewmember becomes medically or physically unfit for duty they shall vocally notify the appropriate aviation manager, [and] self-ground .

The operator disseminated periodic publications on various topics that included fatigue risk management. For example, the winter 2017 edition of the operator's "Safety Connect" publication included a special in-depth feature titled "Drained: Examining the Causes & Remedies of Fatigue." The publication discussed factors that increase fatigue, such as dim lighting, limited visual acuity, high temperatures, high noise, high comfort, tasks over long periods of time, and long, repetitive, monotonous tasks. The feature also included information from the FAA's Advisory Circular 120-115, "Maintainer Fatigue Risk Management."

Administrative Information

Investigator In Charge (IIC):	Malinowski, Edward
Additional Participating Persons:	David Keenan; Federal Aviation Administration; Washington, DC Bryan Larimore; Turbomeca; Grand Praire, TX Emanuele Figlia; Airbus; Grand Praire, TX Dana Metz; Honeywell; Phoenix, AZ Cory Cummins; Air Methods; Denver, CO Peter Hupfer; Federal Aviation Administration; Milwaukee, WI Scott Tyrrell; Federal Aviation Administration; Fort Worth, TX Casey DeLanghe; Appareo Systems; Fargo, ND Xavier DeGastines; Bureau d'Enquêtes et d'Analyses; Paris Raj Helweg; Air Methods; Denver, CO
Original Publish Date:	September 23, 2020
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=97118