Aviation Investigation Final Report

Location:	Perryville, Missouri	**Accident Number:**	CEN17FA252
Date & Time:	July 1, 2017, 20:36 Local	**Registration:**	N238BK
Aircraft:	Airbus Helicopters Deutschland MBB-BK 117 B-2	**Aircraft Damage:**	Substantial
Defining Event:	Fuel starvation	**Injuries:**	5 Minor
Flight Conducted Under:	Part 135: Air taxi & commuter - Non-scheduled - Air Medical (Unspecified)		

Analysis

The airline transport pilot was operating an emergency medical services flight. He reported that, about 17 minutes after takeoff while in cruise flight at dusk, the helicopter "experienced a sharp change in attitude yawing to the left with a hard-upward bump," followed by a change in engine noise. He saw that the engine gas generator speed (N1) gauges for each engine were indicating below 40% and decreasing and that the No. 1 engine low warning light, the No. 1 generator light, and the battery discharge warning lights were illuminated. The pilot stated that the helicopter suddenly "pitched nose up and rolled to the right" and that he then heard the rotor speed begin to deteriorate. He entered an autorotation by applying right forward cyclic and lowering the collective to full down. During the autorotative descent, he saw power lines and a ditch, which required him to change the helicopter's flightpath and land on the far side of the ditch. He flared the helicopter about 100 ft above ground level, and the rotor speed began to decay rapidly. He stated that he attempted to level the helicopter "as it began to fall," but the helicopter landed right skid low and then skidded for about 100 ft. The main rotor blades hit the ground as the helicopter rolled onto its right side. The pilot reported that, after exiting the helicopter, he observed fuel draining in a solid stream from a fuel vent port on the helicopter's belly and that he then re-entered the cockpit and turned off all electrical and fuel switches to minimize the risk of fire.

The pilot's recollection of the accident circumstances was consistent with a dual-engine loss of power. Additionally, the damage observed on the rotor system was consistent with the engine not having power at the time of impact. The fuel transfer system between the main tanks and the supply tanks and from the supply tanks to their respective engines and the fuel delivery system functioned normally during operational testing. No residual fuel was found within the engine fuel filter bowl, indicative of no fuel reaching the engines. Based on the pilot's statement that he saw a steady stream of fuel leaking from a fuel vent port on the helicopter's belly shortly after the accident, fuel was likely present within the main fuel tanks.

Therefore, based on the evidence, it is likely that the pilot did not activate the fuel transfer pumps, which resulted in no fuel transferring between the main fuel tanks and the supply tanks and led to eventual fuel starvation. Thus, when the engines consumed all available fuel from their respective supply tanks, the dual-engine loss of power occurred.

The advisory, caution, and warning annunciator panel functioned normally during operational testing. However, postaccident examination of the helicopter revealed that the dimming function was activated, and the pilot confirmed that he dimmed the panel before takeoff. The annunciator panel contains caution lights for when the fuel transfer pumps are off and for when the fuel quantity in each supply tank is low. Illumination of these caution lights leads to the illumination of the master warning light but generates no aural tones. The ambient light at the time of the flight and the pilot's activation of the dimming function in conjunction with the night vision imaging system filters likely precluded the pilot from being able to see the illuminated caution lights on the annunciator panel and an illuminated master warning light.

Probable Cause and Findings

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

Fuel starvation due to the pilot's failure to turn on the fuel transfer pump switches during takeoff, which led to a total loss of engine power. Contributing to the accident was the pilot's improper decision to activate the annunciator panel's dimming function during dusk, which prevented him from seeing the illuminated fuel transfer pump caution light indicating that the pumps were off and the illuminated caution lights for low fuel in the supply tanks.

Findings

Aircraft	Fuel transfer valve - Not used/operated
Personnel issues	Use of equip/system - Pilot
Personnel issues	Decision making/judgment - Pilot
Aircraft	Flight compartment lighting - Incorrect use/operation
Aircraft	Data recorders (flight/maint) - Not installed/available

Factual Information

History of Flight

Enroute	Miscellaneous/other
Enroute	Fuel starvation (Defining event)
Enroute	Loss of engine power (total)
Autorotation	Hard landing

On July 1, 2017, about 2036 central daylight time, an Airbus Helicopters Deutschland, MBB-BK 117 B-2, N238BK, helicopter, landed hard and rolled over during an emergency landing to a field near Perryville, Missouri. The pilot, three crew members, and a passenger received minor injuries, and the helicopter sustained substantial damage. The helicopter was owned and operated by Air Methods Corporation, doing business as Kids Flight, as a 14 *Code of Federal Regulations* Part 135 medical flight. Visual meteorological conditions (dusk) prevailed at the time of the accident, and a company visual flight rules flight plan was filed. The flight originated from the St. Francis Medical Center (MO50), Cape Girardeau, Missouri, about 2019 and was en route to the St. Louis Children's Hospital (2MU1), St. Louis, Missouri.

The pilot reported that at 1901, he was notified by the Air Methods Communication Center (AirCom) concerning a flight request. The pilot accepted the flight and after ensuring all necessary requirements were completed, the flight departed at 1922 for MO50, which was approximately 50 nautical miles (nm) to the southeast. The pilot reported that the helicopter departed with 140 gallons of fuel in the main fuel tanks. The flight arrived at MO50 about 1949.

About 2015, the medical crew arrived at the helicopter pad and loaded the patient on board the helicopter. About 2019, the helicopter departed for 2MU1, which was approximately 85 nm on a 338° heading. Sunset was about 2025 with the sun setting on a 300° azimuth. The pilot reported that there was 110 gallons in the main fuel tanks.

The pilot reported that after 15 minutes of flight, he scanned the instruments and gauges "noting that all systems were in the normal range and fuel was transferring from the main tank." He reported that the fuel level indication was approximately 95 gallons in the main tanks and the supply tanks were "just below the full indication," and that there were no illuminated lights on the warning/caution panel. The airspeed was 120 kts at an altitude of 1,600 ft above mean sea level - about 1,200 ft above ground level (agl).

The pilot reported that when the flight was about 5 miles north of Perryville, Missouri, the helicopter "experienced a sharp change in attitude yawing to the left with a hard-upward bump," followed by a change in the engine noise. He observed the N1 gauges both indicating below 40 per cent and decreasing. The No. 1 engine low warning light, the No. 1 generator light, and the battery discharge warning lights were illuminated. He stated, "Suddenly the aircraft pitched nose up and rolled to the right. I could hear the rotor begin to deteriorate." He entered an autorotation by applying right forward cyclic

and lowering the collective to full down.

During the autorotative descent, he saw power lines and a ditch which required him to change his flight path to land on the far side of the ditch. He flared the helicopter about 100 ft agl and the rotor rpm began to decay rapidly. He attempted to level the helicopter "as it began to fall through." The helicopter landed right skid low and the helicopter skidded for about 100 ft. The main rotor blades hit the ground as the helicopter rolled onto its right side. Once the helicopter came to a rest, he pulled the power levers to the stop position.

The pilot and flight crew, with the patient on a stretcher, egressed the helicopter. The pilot reported that he observed fuel draining in a solid stream from one of the drains on the belly of the helicopter. He re-entered the cockpit and turned off all electrical and fuel switches to minimize the risk of fire.

Pilot Information

Certificate:	Airline transport	**Age:**	59,Male
Airplane Rating(s):	None	**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:**	No
Medical Certification:	Class 2 With waivers/limitations	**Last FAA Medical Exam:**	February 21, 2017
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	June 20, 2017
Flight Time:	6237 hours (Total, all aircraft), 308 hours (Total, this make and model), 6237 hours (Pilot In Command, all aircraft), 34 hours (Last 90 days, all aircraft), 14 hours (Last 30 days, all aircraft), 1 hours (Last 24 hours, all aircraft)		

The pilot, age 59, held an Federal Aviation Administration (FAA) airline transport pilot certificate with a rotorcraft helicopter, and instrument helicopter ratings. The pilot's most recent FAA second-class medical certificate was dated February 21, 2017, with a restriction for corrective lenses. He had 6,237 hours of total flight time with 308 hours of flight time in the make and model of the accident helicopter.

Aircraft and Owner/Operator Information

Aircraft Make:	Airbus Helicopters Deutschland	**Registration:**	N238BK
Model/Series:	MBB-BK 117 B-2	**Aircraft Category:**	Helicopter
Year of Manufacture:	1991	**Amateur Built:**	
Airworthiness Certificate:	Transport	**Serial Number:**	7238
Landing Gear Type:	Skid	**Seats:**	6
Date/Type of Last Inspection:	June 30, 2017 AAIP	**Certified Max Gross Wt.:**	7385 lbs
Time Since Last Inspection:		**Engines:**	2 Turbo shaft
Airframe Total Time:	12150 Hrs at time of accident	**Engine Manufacturer:**	Honeywell
ELT:	C126 installed, activated, did not aid in locating accident	**Engine Model/Series:**	LTS101-750B-1
Registered Owner:	AIR METHODS CORP	**Rated Power:**	750 Horsepower
Operator:	AIR METHODS CORP	**Operating Certificate(s) Held:**	On-demand air taxi (135)
Operator Does Business As:	Kids Flight	**Operator Designator Code:**	QLMA

The Airbus Helicopters Deutschland MBB-BK 117 B-2 helicopter has a four-bladed rigid main rotor system that provides helicopter lift and thrust. A two-bladed tail rotor system provides anti- torque and directional control. The helicopter flight controls are hydraulically assisted by a dual hydraulic system. The helicopter was equipped with a skid-type landing gear and two Honeywell LTS101-750B-1 turboshaft engine. The BK117 B-2 helicopter is type certificated under FAA Type Certificate Data Sheet (TCDS) No. H13EU as a Transport Category A & B helicopter.

The accident helicopter, serial number (S/N) 7238, was manufactured in 1991. According to helicopter records, the airframe had accumulated an aircraft total time (ATT) of about 12,150 flight hours the day prior to the accident. The engines installed on the accident helicopter were S/Ns LE45662 AEF and LE45681 EFA, positioned as the No. 1 (left) and No. 2 (right) engines, respectively. The No. 1 engine had accumulated about 9,799.53 hours, about 27,502.20 generator cycles, and about 22,451.90 power turbine cycles around the time of the accident. The No. 2 engine had accumulated about 10,193.60 hours, 27,278.27 gas generator cycles, and 20,832.55 power turbine cycles.

A night vision goggle (NVG) compatible interior lighting system, manufactured by Ahlers Aerospace, Inc., was installed under FAA Supplemental Type Certificate (STC) No. SR09523RC. The night vision imaging system (NVIS) kit uses infrared filters that are installed externally to the faces of instruments and displays to reduce or eliminate infrared glare. An infrared filter is also placed over the advisory, caution, and warning annunciator panel. STC No. SR09523RC does not affect the instrument lighting controls originally installed on the helicopter.

Helicopter Fuel System Description

The helicopter fuel system comprises the fuel storage system, fuel supply system, and fuel monitoring

system. The fuel storage system consists of the fuel tanks, tank vent system, tank drain valves, and filler neck. The fuel supply system consists of the fuel tank pumps, fuel lines, and emergency fuel shutoff valves. The fuel monitoring system consists of the fuel quantity indicator, low fuel warning, fuel pressure waning, and fuel filter contamination warning.

The helicopter contains four flexible fuel tank bladders: an 80 kg fuel tank, forward main tank, left and right prime (supply) tank, and a rear main tank. The 80 kg fuel tank is connected to the forward main tank via one interconnecting tube. The forward main tank is connected to each supply tank via overflow tubes. The left and right supply tanks are separated but glued together. The left supply tank supplies fuel to the No. 1 engine and the right supply tank supplies fuel to the No. 2 engine. The rear main tank carries the fuel filler neck and is connected to the forward main tank via two upper and one lower interconnecting tubes. The total usable fuel capacity of all fuel tanks is about 184.2 gallons. The 80 kg fuel tank holds about 26.3 gallons, the forward and aft main fuel tanks combined holds about 132.4 gallons, and both supply tanks combined holds about 25.5 gallons.

There are four fuel pumps within the helicopter fuel system: two fuel prime pumps and two fuel transfer pumps. Each supply tank contains a prime pump that delivers fuel to the engines via feed lines during engine start. The prime pumps are identified "left" and "right" based on the supply tank in which they reside. The prime pumps are activated using a toggle switch on the center console of the helicopter. Activation of the prime pumps illuminates the "PRIME PUMPS" caution light on the advisory, caution, and warning annunciator panel in the cockpit. Once the engines are running, the engine-driven fuel pumps draw fuel from the supply tanks and the prime pumps can be turned off. Deactivation of the prime pumps extinguishes the "PRIME PUMPS" caution light. The two fuel transfer pumps are identified "forward" and "aft". Both fuel transfer pumps are located within the forward main tank. The transfer pumps deliver fuel from the main fuel tanks to the supply tanks and must be activated during helicopter operation. The capacity of the transfer pumps allows for more fuel to be transferred into the supply tanks than the engines can consume. Any surplus fuel in the supply tanks return to the main fuel tanks via overflow tubes. When the transfer pumps are deactivated, the "F PUMP XFER FWD" and "F PUMP XFER AFT" caution lights illuminate on the annunciator panel. Activation of the respective transfer pumps extinguishes the associated caution lights.

Each supply tank contains a fuel quantity transmitter. Additionally, fuel quantity transmitters are installed in the forward main tank and the 80 kg fuel tank. The fuel quantity indicator (gauge) in the cockpit shows three values in gallons: the main fuel tank quantity, the left supply tank fuel quantity, and right supply tank fuel quantity. Each supply tank contains a low fuel warning transmitter that detects when its respective supply tank contains less than 7.6 gallons of fuel. Activation of the low fuel warning transmitter results in illumination of the "FUEL LOW I" or "FUEL LOW II" caution light on the annunciator panel for the left supply tank and right supply tank, respectively.

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Dusk
Observation Facility, Elevation:	SAR,538 ft msl	**Distance from Accident Site:**	15 Nautical Miles
Observation Time:	19:55 Local	**Direction from Accident Site:**	20°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	/ None	**Turbulence Type Forecast/Actual:**	/
Wind Direction:		**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.04 inches Hg	**Temperature/Dew Point:**	26°C / 17°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Cape Girardeau, MO (MO50)	**Type of Flight Plan Filed:**	Company VFR
Destination:	St. Louis, MO (2MU1)	**Type of Clearance:**	None
Departure Time:	20:19 Local	**Type of Airspace:**	

At 1955, the surface weather observation at Hunter Field (SAR), Sparta, Illinois, located 15 nm northeast of the accident site, was: wind light and variable; 10 miles visibility; sky clear; temperature 26° C; dew point 17° C; altimeter 30.05 inches of mercury.

Wreckage and Impact Information

Crew Injuries:	4 Minor	**Aircraft Damage:**	Substantial
Passenger Injuries:	1 Minor	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	5 Minor	**Latitude, Longitude:**	37.841667,-89.80722(est)

The helicopter's main fuselage was found resting on its right side in a farm field. The surrounding vegetation was relatively low, and the terrain was relatively flat. The right skid had fractured and partially separated from the main fuselage. The left skid tube appeared relatively intact. Dirt was visible on the underside of the main fuselage. The aft-right loading door was opened, and the aft-left loading door remained closed. The front-left chin bubble was fractured and the wire strike protection cutter on the helicopter chin was partially separated from the fuselage.

The tail boom and empennage had separated from the main fuselage but were located immediately adjacent to the main fuselage. The tail boom and empennage came to rest inverted. The tail rotor and tail rotor gearbox remained attached to the vertical fin. One of the two tail rotor blades exhibited a broomstrawed appearance and the other appeared relatively intact. Three of the four main rotor blades

appeared to be underneath the main fuselage with their tip ends generally pointed in the aft direction. The fourth main rotor blade tip end was generally pointed to the 4 o'clock direction.

The two-fuel prime pump and the two fuel transfer pump switches were in the "off" position. The two fuel shutoff valve switches were in the "open" position and the switch guards remained "closed". The position, anti-collision, and strobe light switches were found in the "on" position. The copilot, engine, and pilot instrument panel lighting dials (rotary switches) were set to the "BR" (bright) position. According to helicopter operator's representatives, after the helicopter was moved upright, the forward battery was reconnected, and the annunciator panel and master warning light were dim. When the instrument panel lighting dials were set to the "off" position, all expected lights were illuminated. Additionally, the fuel gauges for the No. 1 and No. 2 supply tanks indicated zero and the main fuel tank indicated about 25 gallons.

Fuel was observed leaking from the bottom of the helicopter, which was attributed to be the fuel vent lines. The flexible fuel line leading to the fuel filter for the No. 2 engine was removed and less than "one teaspoon" (0.16 fluid ounces or 4.9 milliliters) came out of the flexible fuel line and filter.

The accident helicopter was recovered and relocated to an aviation wreckage storage facility for further examination.

Medical and Pathological Information

The pilot was tested for drugs and alcohol about 16 hours after the accident. The results were negative.

Tests and Research

On August 8-9, 2017, representatives from the National Transportation Safety Board (NTSB), FAA, German Federal Bureau of Aircraft Accident Investigation (BFU), Air Methods, Airbus Helicopters, and Honeywell examined the recovered wreckage.

Cockpit Instrument Lighting

All three instrument panel lighting dials were observed to be in the "off" position. The main and secondary battery switches and the master power switch were turned on. Several lights on the annunciator panel as well as both left and right master warning lights illuminated. Depressing the annunciator panel test button illuminated all advisory, caution, and warning lights on the annunciator except for one light bank located on the third column (from the left) and bottom row. The advisory, caution, and warning lights appeared bright with even illumination. The master warning light extinguished while it was depressed, but releasing the light resulted in it illuminating again.

Rotating the copilot instrument lighting dial resulted in no effect to the dimming of the annunciator

lights as well as the master warning light. Rotating the engine and pilot instrument panel lighting dials resulted in dimming of the annunciator lights as well as the master warning light. When the annunciator lights were dimmed using the pilot instrument lighting dial and the annunciator panel test button was depressed, the following was observed:

- The "ENG I LOW", "ROTOR RPM", "ENG II LOW", and "XMSN OIL PRESS" lights were dimmed but still visible.
- The "ENG II CHIP" light was at full brightness and visible.
- The "BAT DISCH", "EXT PWR", "CSAS ROLL", and "CSAS YAW" lights were dimmed and partially visible.
- The remaining advisory, caution, and warning lights on the annunciator panel were not visible.
- The master warning light had dimmed to a level where its illumination was not readily distinguishable.

Engines

The Nos. 1 and 2 engine fuel filter bowl safety wiring remained intact. The safety wiring was removed, and the filter bowls were unscrewed from their respective housings. The Nos. 1 and 2 engine fuel filter bowl revealed about 0.08 – 0.16 fluid ounces of fuel and the filter element was undamaged and clear of debris.

Continuity of control was established between the engine control levers in the cockpit to the fuel control of each engine. Collective stick movement produced a corresponding movement of the power turbine governor control linkages.

Rotation of the power turbine for both the Nos. 1 and 2 engines resulted in movement of their respective input drive shaft (to the main transmission) and the main rotor. Freewheeling unit functionality for both the No. 1 and No. 2 engines input was confirmed by manual rotation of their respective power turbine in the direction opposite of normal drive. All power turbine blades were visually accounted for on the No. 1 and No. 2 engines.

The inlet screens for both engines exhibited no evidence of blockages. The inlet screens were removed, and a tactile check of the Nos. 1 and 2 engines first stage compressor blades was performed; the leading edges of the first stage compressor blades for the No. 1 engine was comparatively "less rough" than that of the No. 2 engine. Both engines' compressors rotated freely. Rotation of the both engines' compressor resulted in a corresponding rotation of the starter/generator, consistent with continuity of the gear train through the gas producer section of the reduction gearbox.

The oil levels for both engines were found to be adequate. For both engines, the chip detectors at the reduction gearbox, rear bearing support housing, and airframe facet filter showed no evidence of metallic debris. Functionality of the rear bearing support housing and airframe facet filter were verified by inserting a ferrous object onto the detector and observing the associated chip detector light illuminate on the cockpit annunciator panel.

Helicopter Fuel System Functional Test

A functional test of the helicopter fuel system was conducted to determine functionality of the fuel prime pumps and fuel transfer pumps. The right fuel line to the No. 2 engine fuel inlet was disconnected and about 0.08 – 0.16 fluid ounces of fuel leaked when the "B" nut was loosened. With the batteries and master power switch on, the right fuel valve switch was set to the "open" position and a faint noise was heard in the location of the right fuel valve. The faint noise appeared consistent with the right fuel valve resetting. The "FUEL VALVE II" light illuminated during valve operation. The left fuel valve switched was set to the "open" position and a faint noise was heard in the location of the left fuel valve. The faint noise appeared consistent with the left fuel valve resetting. The "FUEL VALVE I" light illuminated during valve operation. The fuel gauge for the main fuel tank indicated about 14 gallons. The fuel gauge for the left supply tank indicated zero gallons and the right supply tank indicated about 1 gallon. The right fuel prime pump switch was set to "on" and a sound consistent with pump operation was heard. The "PRIME PUMPS" light illuminated. Visual inspection of the [disconnected] right fuel line to the No. 2 engine fuel inlet showed fuel was observed pumping out of the fuel line, and the fuel gauge for the right supply tank dropped to near- zero. When the right fuel prime pump switched was set to "off", the "PRIME PUMPS" light extinguished, and the pump stopped running. The left fuel line to the engine fuel inlet was disconnected; a couple of drops of fuel was observed when the "B" nut was loosened. The left fuel prime pump switch was set to "on" and a sound consistent with pump operation was heard. The "PRIME PUMPS" light illuminated. Visual inspection of the [disconnected] left fuel line to the No. 1 engine fuel inlet showed fuel was observed pumping out of the fuel line. The fuel gauge for the left supply tank remained at zero. When the left fuel prime pump switched was then set to "off", the "PRIME PUMPS" light extinguished, and the pump stopped running.

The main fuel tank was filled with Jet A fuel until the fuel gauge for the main fuel tank indicated about 50 gallons. The main fuel tank was filled incrementally to verify the fuel gauge was accurately indicating fuel quantity. Initially, about 10 gallons of Jet A fuel was added to the main fuel tank, and the fuel gauge indicated about 25 gallons. Subsequently, about 15 gallons and then 10 gallons were added to the main fuel tank, and the fuel gauge indicated about 39 gallons and 50 gallons, respectively.

The forward fuel transfer pump switch was set to "on" with the intent to transfer about 5 gallons of fuel from the main tank to both supply tanks. The "F PUMP XFER FWD" caution light extinguished and a noise consistent with fuel pump operation was heard. About 2 minutes and 19 seconds after the forward fuel transfer pump was turned on, the right supply tank indicated about 5 gallons, the left supply tank indicated about 4 gallons, and the main fuel tank indicated about 40 gallons. Both "FUEL LOW I" and "FUEL LOW II" lights remained illuminated. When the forward fuel transfer pump switch was set to "off", the "F PUMP XFER FWD" light illuminated, and the pump stopped running.

The aft fuel transfer pump switch was set to "on" with the intent to run the pump until the "FUEL LOW I" and "FUEL LOW II" lights extinguished. The "F PUMP XFER AFT" caution light extinguished and a noise consistent with fuel pump operation was heard. About 1 minute after the aft fuel transfer pump was turned on, the "FUEL LOW II" light extinguished, and the right supply tank indicated about 8 gallons. The "FUEL LOW I" light remained illuminated and the left supply tank indicated about 6 gallons. About 45 seconds later, the "FUEL LOW I" light extinguished; at this time the left supply tank indicated about 7 gallons while the right supply tank indicated about 9 gallons. When the aft fuel

transfer pump switch was then set to "off", the "F PUMP XFER AFT" light illuminated, and the pump stopped running.

The left fuel prime pump switch was set to "on" with the intent to run the pump until the "FUEL LOW I" light illuminated. During operation of the left fuel prime pump, the "PRIME PUMPS" light illuminated, and fuel was observed pumping out of the fuel line to the No. 1 engine fuel inlet. About 20 seconds later the "FUEL LOW I" light illuminated, and the left supply tank indicated about 7 gallons. The left fuel prime pump switch was set to "off" and the pump stopped running.

The right fuel prime pump switch was set to "on" with the intent to run the pump until the "FUEL LOW II" light illuminated. The master warning light was reset by depressing the light. During operation of the right fuel prime pump, the "PRIME PUMPS" light illuminated, and fuel was observed pumping out of the fuel line to the No. 2 engine fuel inlet. About 37 seconds later the "FUEL LOW II" light illuminated along with the master warning light. The right supply tank indicated about 7 gallons. The right fuel prime pump switch was set to "off" and the pump stopped running.

Engine Fuel System Functional Test

A functional test of the engine fuel system was conducted to determine functionality of fuel delivery to the fuel manifold. To set up for the test, the circuit breaker for the igniters were pulled and the power supply connectors to the ignition units on the engines were disconnected. For each engine, the fuel line between the fuel control and the fuel manifold was disconnected to observe fuel coming out of the fuel control. When the manifold line was disconnected, residual fuel was observed coming out of the line. The engine control lever for the No. 1 engine was set to idle. After the left fuel prime pump switch was turned "on", the "FUEL PRESS I" light extinguished and the "FUEL FILTER I" light remained extinguished. The No. 1 engine was motored by depressing and holding the starter button. After about 10 seconds, fuel was observed to be coming out of the fuel line between the No. 1 engine fuel control and manifold. With the No. 1 engine continuing to be motored, the left fuel prime pump was turned off and fuel continued to come out of the manifold line, consistent with the No. 1 engine-driven fuel pump moving fuel through the No. 1 engine fuel components. The starter button was released, and fuel flow ceased out of the manifold line.

The engine control lever for the No. 2 engine was set to idle. After the right fuel prime pump switch was turned "on", the "FUEL PRESS II" light extinguished and the "FUEL FILTER II" light remained extinguished. The No. 2 engine was motored by depressing and holding the starter button. After about 10 seconds, fuel was observed to be coming out of the fuel line between the No. 2 engine fuel control and manifold. With the No. 2 engine continuing to be motored, the right fuel prime pump was turned off and fuel continued to come out of the manifold line, consistent with the No. 2 engine-driven fuel pump moving fuel through the No. 2 engine fuel components. The starter button was released, and fuel flow ceased out of the manifold line.

Additional Information

Related cases

On July 20, 2001, a BK117 C-1 helicopter, N313LS, experienced a dual engine power loss in flight and autorotated into a field near Decatur, Texas. The pilot reported not seeing any warning lights prior to the loss of engine power. However, it was noted during the postaccident examination of the helicopter that the dimming function of the pilot instrument and console instrument lighting was turned on. Although the fuel transfer pump switches were found in the "on" position, examination of the fuel system provided evidence that the dual engine power loss was the result of fuel starvation due to these switches not being on during the majority of the flight. It was noted that the fuel transfer pump caution lights extinguished when the fuel transfer pumps were turned on.

On May 5, 2014, a Kawasaki BK117 B-2 helicopter, ZK-HJC, experienced a dual engine power loss in flight and performed a successful autorotation near Springston, Canterbury, New Zealand. The New Zealand Transport Accident Investigation Commission (TAIC) opened an investigation and published their findings in report No. AO-2014-002. Key findings regarding the helicopter included:

- Both engines lost power due to fuel starvation because the pilot did not switch on the fuel transfer pumps after starting the engines.
- A cockpit lighting modification to the helicopter had adversely affected the readability of the caution lights during daylight when the dimmer switch was on. Brightly illuminated caution lights should have alerted the pilot to the incorrectly configured fuel system and the low fuel levels in the supply tanks.
- The helicopter was not designed to generate an aural warning of a critically low fuel level in the supply tanks. An aural warning, as fitted to later designs, would have alerted the pilot to the potential loss of engine power.
- A previous event in New Zealand in 2011 involving a BK117 A-3 that experienced a loss of engine power due to fuel starvation but landed safely. The cockpit lighting dimming function was reported to be on during daylight conditions.

The BFU provided the NTSB with correspondence between the FAA Rotorcraft Directorate Aircraft Certification Service (ASW-100) and the FAA Recommendation and Quality Assurance Division (AAI-200) which discussed fuel starvation accidents involving MBB Bo-105-series helicopters and recommendations. The correspondence, spanning from 1992 to 1994, discussed accidents in which the fuel transfer pump switches were not turned on in flight. Similar to the BK117-series helicopter, the Bo-105-series helicopter contains a main fuel tank and a supply tank, the latter of which feeds the No. 1 and No. 2 engines. Pumps transfer fuel from the main fuel tank to the supply tank. A low fuel warning transmitter in the supply tank triggers a low fuel light in the cockpit annunciator panel but there is no associated aural warning.

Parties to the investigation included the FAA, Air Methods Corporation, Honeywell, and the BFU, with Airbus as its technical advisor.

Administrative Information

Investigator In Charge (IIC):	Silliman, James
Additional Participating Persons:	Harvinder Pujji; FAA St. Louis FSDO; St. Anne, MO Jason Quisling; Air Methods Corporation; Englewood, CO David Studtmann; Honeywell; Phoenix, AZ Axel Rokohl; German BFU; Braunschweig Seth Buttner; Airbus Helicopters; Grand Prairie, TX
Original Publish Date:	December 16, 2019
Last Revision Date:	July 3, 2024
Investigation Class:	Class
Note:	The NTSB did not travel to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=95485