



NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Washington, D.C. 20594

October 11, 2018

AIRWORTHINESS GROUP CHAIRMAN'S FACTUAL REPORT

NTSB No: CEN17FA252

A. ACCIDENT

Operator: Air Methods Corporation
Aircraft: Airbus Helicopters Deutschland MBB-BK117 B-2, Registration N238BK
Location: Perryville, Missouri
Date: July 1, 2017
Time: 2036 central daylight time

B. GROUP

Group Chairman:	Chihoon Shin National Transportation Safety Board Washington, District of Columbia
Member:	Matthew Rigsby Federal Aviation Administration Fort Worth, Texas
Member:	Harvinder Pujji Federal Aviation Administration St. Ann, Missouri
Member:	Michael Stacey Air Methods Corporation Englewood, Colorado
Member:	Jason Quisling Air Methods Corporation Englewood, Colorado
Member:	David Studtmann Honeywell Aerospace Phoenix, Arizona
Member:	Axel Rokohl Bundesstelle für Flugunfalluntersuchung Braunschweig, Germany

Member:	Seth Buttner Airbus Helicopters Incorporated Grand Prairie, Texas
Member:	Roland Vietzke Airbus Helicopters Deutschland GmbH Donauwörth, Germany

LIST OF ACRONYMS

AAI-200	Recommendation and Quality Assurance Division
ALF	aft-looking-forward
ASW-100	Rotorcraft Directorate Aircraft Certification Service
ATT	aircraft total time
BFU	Bundesstelle für Flugunfalluntersuchung
CDT	central daylight time
CFR	Code of Federal Regulations
ECD	Eurocopter Deutschland
FAA	Federal Aviation Administration
ICAO	International Civil Aviation Organization
MBB	Messerschmitt-Bölkow-Blohm
MO	Missouri
MO50	St. Francis Medical Center
NTSB	National Transportation Safety Board
NVG	night vision goggles
NVIS	night vision imaging system
N1	gas generator speed
RFM	rotorcraft flight manual
STC	supplemental type certificate
S/N	serial number
TCDS	Type Certificate Data Sheet
2MU1	St. Louis Children's Hospital

C. SUMMARY

On July 1, 2017, about 2036 central daylight time (CDT), an Airbus Helicopters Deutschland¹ MBB-BK117 B-2² helicopter, N238BK, landed hard and rolled over during an emergency landing to a field near Perryville, Missouri (MO). 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, and the flight was operated under 14 *Code of Federal Regulations* (CFR) Part 135 as a helicopter air ambulance flight. Visual meteorological conditions 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 CDT and was en route to the St. Louis Children's Hospital (2MU1), St. Louis, Missouri.

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 engine gas generator speed (N1) gauges for each engine indicating below 40 percent and decreasing. The No. 1 engine low warning light, the No. 1 generator light, and the battery discharge warning lights were illuminated. He described that the helicopter suddenly pitched nose up and rolled slightly to the right and he could hear 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 his flight path to land on the far side of the ditch. He flared the helicopter at a height of about 100 feet and the rotor speed 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 feet. 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 and re-entered the cockpit and turned off all electrical and fuel switches to minimize the risk of fire.

D. DETAILS OF THE INVESTIGATION

1.0 HELICOPTER INFORMATION

1.1 HELICOPTER DESCRIPTION

The Airbus Helicopters Deutschland BK117 B-2 helicopter has a four-bladed rigid main rotor system that provides helicopter lift and thrust.³ 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 Honeywell⁴ LTS101-750B-1 turboshaft engine. The BK117 B-2 helicopter is type certificated under Federal

¹ Airbus Helicopter Deutschland was formerly named Eurocopter Deutschland (ECD) and Messerschmitt-Bölkow-Blohm (MBB) prior to ECD.

² All BK117-series helicopters referenced in this report are MBB-BK117 models unless otherwise specified.

³ The main rotor blades rotate in a counter-clockwise direction when looking down at the main rotor disk from above.

⁴ The LTS101-series engines were originally designed and manufactured by Lycoming Turbine Engines.

Aviation Administration (FAA) Type Certificate Data Sheet (TCDS) No. H13EU as a Transport Category A & B helicopter.

The terms “left”, “right”, “up”, and “down” are used when in the frame of reference of looking forward from the aft end of the helicopter, i.e. aft-looking-forward (ALF). All locations and directions will be viewed from ALF unless otherwise specified. Additionally, clock positions are in the ALF frame of reference unless otherwise specified.

1.2 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 warning, 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 (**Figure 1**). 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 filter 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. **Figure 2** shows how the fuel tanks are interconnected.

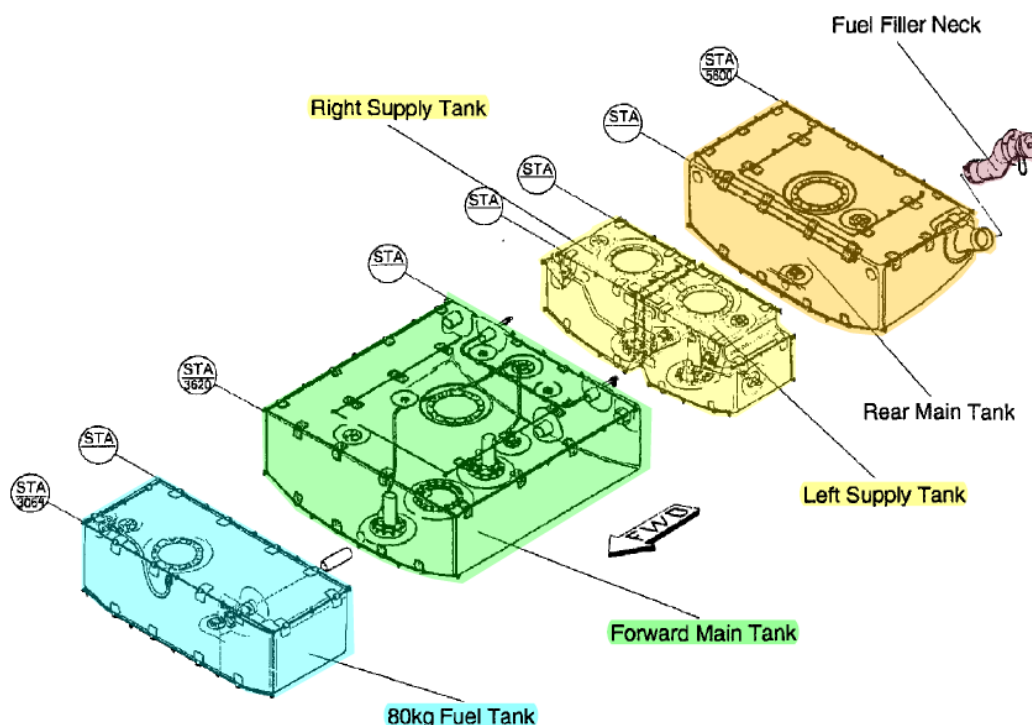


Figure 1. The fuel tanks on the BK117-B2 helicopter. (courtesy of Airbus Helicopters)

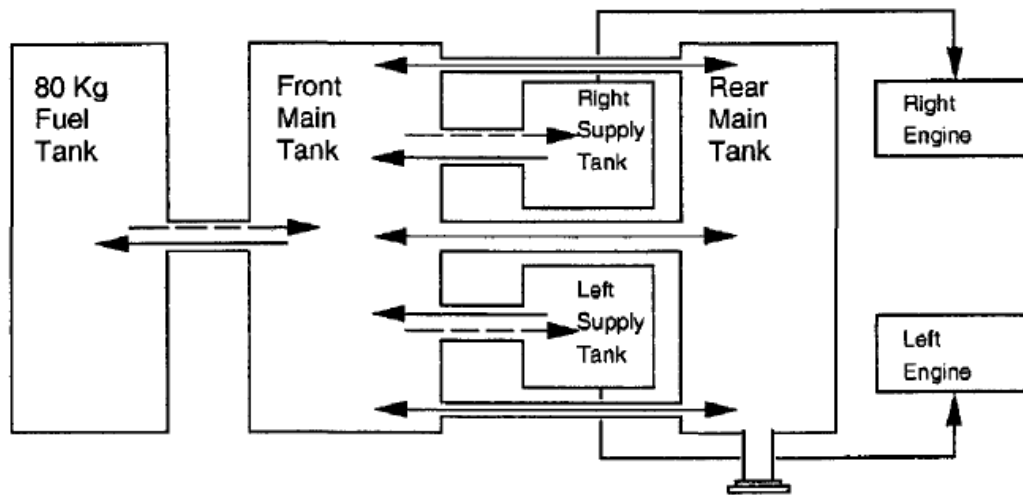


Figure 2. Fuel tank schematic showing fuel flow between the tanks. (courtesy of Airbus Helicopters)

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.

1.3 HELICOPTER HISTORY

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 gas

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.

2.0 WRECKAGE DOCUMENTATION AT THE ACCIDENT SITE

Personnel from the FAA and Air Methods who were at the accident site provided photographs to the National Transportation Safety Board (NTSB). The photographs showed the helicopter main fuselage resting on its right side on a farm field (**Figure 3**). 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. Air Methods personnel disconnected the forward and aft batteries as well as the emergency locator transmitter.



Figure 3. The accident helicopter at the accident site. (courtesy of the FAA)

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.

Photos from inside the cockpit showed the two fuel prime pump and the two fuel transfer pump switches were in the “off” position (**Figure 3**). 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.⁵ According to Air Methods 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. The forward battery was disconnected prior to relocation of the helicopter.

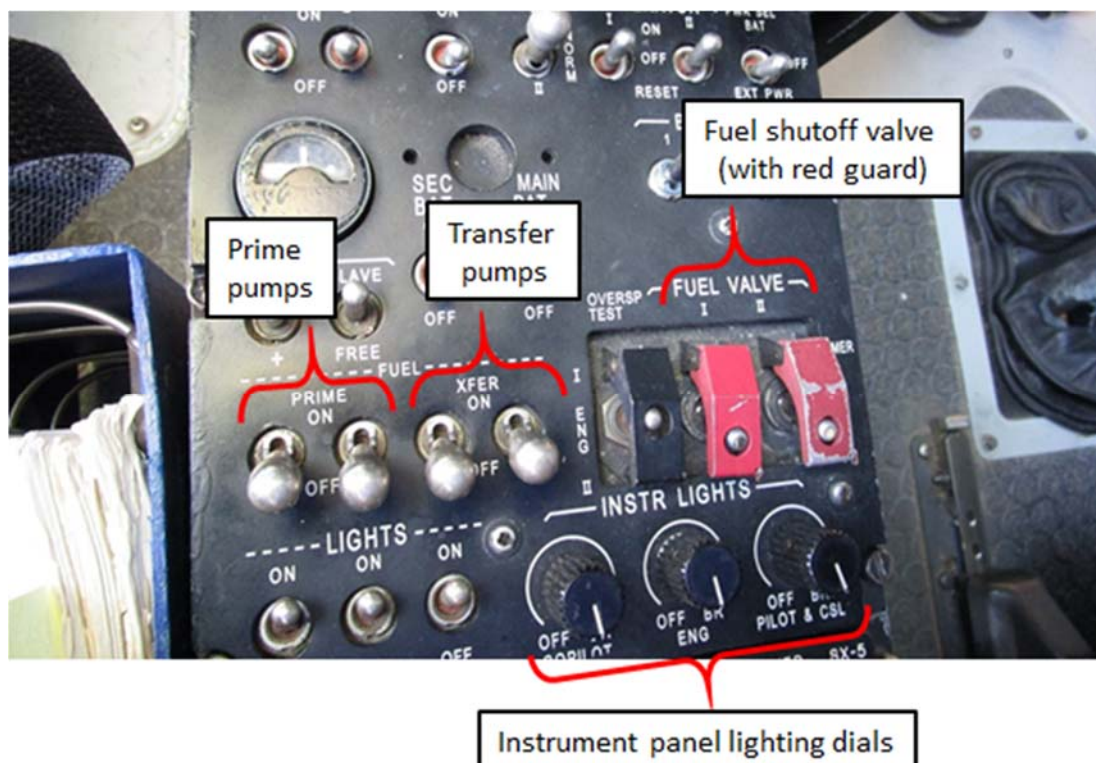


Figure 3. The center console containing the fuel prime pump, fuel transfer pump, and fuel shutoff valve switches as well as the instrument lighting dials. (courtesy of the FAA)

According to Perry County Sheriff’s Department, fuel was observed leaking from the bottom of the helicopter, which was attributed to be the fuel vent lines. According to FAA and Air Methods representatives who were at the accident site, 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.

⁵ The instrument panel lighting dials are used to control the dimming function of the instrument lighting. The dials have an “off” position that disables the dimming function, offering full brightness to the instrument lights. When the dial is rotated clockwise past the “off” position and into the variable dimmer range, the user experiences tactile feedback of moving the dial out of the “off” detent and an audible “click” can be heard. Similarly, tactile feedback is experienced when rotating the dial counterclockwise from the variable dimmer range to the “off” detent. When the dial is in the variable dimmer range, rotating the dial clockwise toward the “BR” (bright) setting increases instrument lighting brightness. However, the brightness of the advisory, caution and warning annunciator panel lighting as well as the master warning light could not be variably adjusted. When the applicable dials affecting brightness of the annunciator panel lighting rotated past the “off” detent, the annunciator panel and the master warning light would dim to a single level of brightness.

The accident helicopter was recovered and relocated to AMF Aviation in Springfield, Tennessee.

3.0 WRECKAGE DOCUMENTATION AFTER RECOVERY

On August 8-9, 2017, representatives from the NTSB, Bundesstelle für Flugunfalluntersuchung⁶ (BFU), FAA, Air Methods, Airbus Helicopters, and Honeywell convened at AMF Aviation in Springfield, Tennessee to examine the recovered wreckage. The examination was focused on the helicopter fuel system, engines, and cockpit instrument lighting. The helicopter main fuselage was stored upright inside a hangar and both engines remained installed on the airframe. The left and right skids, main rotor blades, tail boom and empennage were stored separately. The two fuel shutoff valve switch guards were in the “open” position and the two fuel valves switches were in the “closed” position.

3.1 COCKPIT INSTRUMENT LIGHTING

All three instrument panel lighting dials were observed to be in the “off” position. The forward and aft batteries were reconnected. 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 (**Figure 4**). 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 (**Figure 5**). 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.

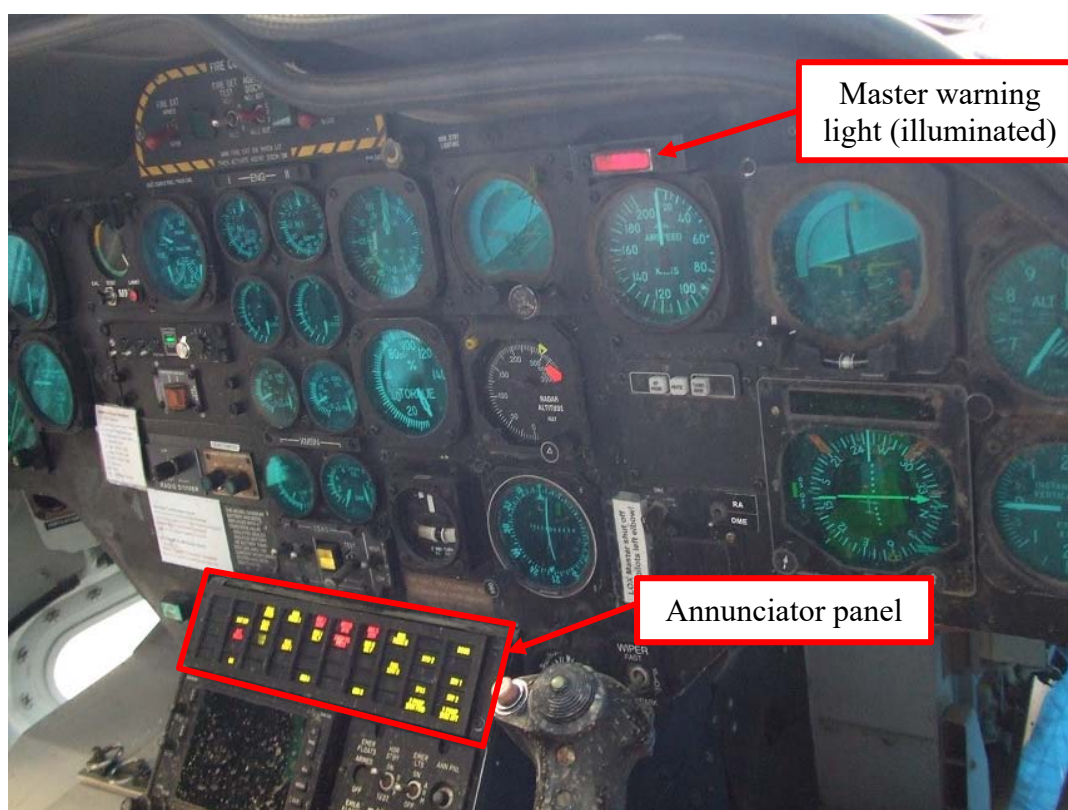


Figure 4. The cockpit instrument panel after the master power switch was turned on.

⁶ The BFU is the German Federal Bureau of Aircraft Accident Investigation. The BFU appointed an accredited representative to assist the NTSB investigation under the provisions of the International Civil Aviation Organization (ICAO) Annex 13.



Figure 5. The advisory, caution, and warning annunciator panel with the dimming function turned off and the annunciator panel test button depressed. (courtesy of Air Methods)

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 (**Figure 6**):⁷

- 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.

The instrument panel lighting dials were all returned to the “off” position.

⁷ The hangar doors were closed but due to the semi-opaque hangar roof the lighting conditions were similar to that of a cloudy day.



Figure 6. The advisory, caution, and warning annunciator panel with the dimming function turned on and the annunciator panel test button depressed. (courtesy of Air Methods)

3.2 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. (**Figures 7 through 10**)



Figure 7. No. 1 engine fuel filter bowl.



Figure 8. No. 1 engine fuel filter.



Figure 9. No. 2 engine fuel filter bowl.



Figure 10. No. 2 engine fuel filter.

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 engine 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 engine 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 engine.

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 engine 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.

3.3 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. A level placed on the cabin floor found it to be longitudinally level.⁸ 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

⁸ When the BK117 B-2 is resting on its skids, the helicopter typically has a slight nose-up attitude. When the helicopter is in cruise flight, the helicopter typically has a slight nose-down attitude.

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.

3.4 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.

3.5 MISCELLANEOUS OBSERVATIONS

The main, intermediate, and tail gearbox chip detectors exhibited no evidence of metallic debris. Main gearbox chip detector functionality was verified by inserting a ferrous object onto the detector and observing the associated chip detector light illuminate on the cockpit annunciator panel. The hydraulic system exhibited no evidence of leaks. The shuttle valve link between the No. 1 and No. 2 hydraulic systems was intact. The shuttle valve link position was consistent with operation using the No. 1 hydraulic system.

At the end of the examination, in order to defuel the helicopter of the fuel added during system testing, fuel within the main fuel tank was transferred to the supply tanks via the forward and aft fuel transfer pumps until the main fuel tank gauge indicated zero. Subsequently, both prime

pumps were activated to transfer fuel from the respective supply tanks into a barrel. After about 10 minutes of running the forward and aft transfer pumps with the main fuel tank gauge indicating zero, the forward and aft fuel transfer pump caution lights did not illuminate. Manipulation of the forward and aft fuel transfer pump switches resulted in an intermittent illumination of the forward transfer pump caution light, but this condition could not be reliably replicated.

4.0 MAINTENANCE

The accident helicopter was maintained under an approved airworthiness inspection program. According to the accident helicopter maintenance records, the last 100-hour inspection of the was performed on May 26, 2017, about ATT 12,112.7 hours. No anomalous findings were documented. On June 27, 2017, about ATT 12,146.2 hours, a monthly compressor wash was performed, the pneumatic pressure filter for both engines was inspected with no reported anomalous findings, and the igniter plugs for both engines were replaced due to wear beyond limits. On June 28, 2017, about ATT 12,149.7, the triple tachometer was replaced due to erratic readings from the No. 1 needle. On June 29, 2017, about ATT 12,149.7 hours, the No. 2 engine mount components were replaced due to wear beyond limits. On June 30, 2017, the helicopter accumulated about 20 minutes of flight time and concluded the day with ATT 12,150.0 hours.

5.0 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.⁹ 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.¹⁰

⁹ For more information about this investigation, see NTSB case No. FTW01LA166.

¹⁰ According to Airbus Helicopters Deutschland, the BK117 C-2 and later variants provide an aural tone when the low fuel warning annunciates.

- 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.¹¹ The correspondence, spanning from 1992 to 1994, discusses 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.¹² 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. The majority of the recommendations were not accepted but the memo from ASW-100 to AAI-200 references an ECD service bulletin which installs a “transfer pump off” warning light. Attachment 1 of this reports contains the FAA correspondence between ASW-100 and AAI-200.

Chihoon Shin
Aerospace Engineer – Helicopters

¹¹ The Bo-105-series helicopter is type certificated under FAA TCDS No. H3EU as a Normal Category helicopter.

¹² The Bo-105 fuel system originally contained a single supply tank that fed both engines. A service bulletin introduced a supply tank containing 2 tanks, one of which fed the No. 1 engine and the other which fed the No. 2 engine.