**NATIONAL TRANSPORTATIONS SAFETY BOARD**
**Office of Aviation Safety**
**Washington, DC 20594**

**July 9, 2008**

# AIRWORTHINESS GROUP CHAIRMAN FACTUAL REPORT

**DEN08MA116A/B**

## A. ACCIDENT

Location: Flagstaff, Arizona
Date: June 29, 2008
Time: 1547 mountain standard time

**DEN08MA116A**
Aircraft: Bell Textron Canada Model 407, N407GA
Operator: Air Methods Corporation

**DEN08MA116B**
Aircraft: Bell Textron Canada Model 407, N407MJ
Operator: Classic Helicopter Services

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## C. SUMMARY

On June 29, 2008, at 1547 mountain standard time, a Bell 407 emergency medical service (EMS) helicopter, N407GA, and a Bell 407 EMS helicopter, N407MJ, collided in mid air while approaching the Flagstaff Medical Center helipad (3AZ0), Flagstaff, Arizona. Both helicopters were destroyed. N407GA's commercial pilot, flight nurse, and patient sustained fatal injuries; and N407MJ's commercial pilot, flight paramedic, flight nurse, and patient sustained fatal injuries. N407GA was operated by Air Methods Corp., Englewood, Colorado, and registered to Flagstaff Medical Center, Flagstaff, Arizona. N407MJ was operated by Classic Helicopter Services, Page, Arizona, and registered to M&J Leisure, L.L.C., Ogden, Utah. Visual meteorological conditions prevailed. Company flight plans were filed for the Title 14 Code of Federal Regulations Part 135 air medical flights. N407GA's flight departed the Flagstaff Pulliam Airport (FLG), Flagstaff, at 1544, and N407MJ's flight departed the Grand Canyon National Park Service South Rim helibase, Tusayan, Arizona, at 1517.

## D. DESCRIPTION OF ACCIDENT SITE

The accident site was located approximately 1/4 mile east of the Flagstaff Medical Center (FMC) helipad. The helipad elevation was approximately 7,080 feet. The Air Methods Corporation helicopter, N407GA, came to rest on level, sparsely wooded terrain at 7,057 feet elevation. The Classic Aviation Services helicopter, N407MJ, came to rest on sloping, wooded terrain at 7,021 feet elevation; about 300 feet west of the Air Methods helicopter. A rocky embankment, about 25 feet in height, separated the two helicopters.

According to global positioning system (GPS) data, the Air Methods helicopter main wreckage was positioned 0.26 nautical miles (nm) from the FMC helipad on a 073-degree magnetic bearing. The Classic helicopter main wreckage was positioned 0.22 nm from the FMC helipad on a 081-degree magnetic bearing.

## E. SUMMARY OF AIRCRAFT DAMAGE[1][2]

### N407GA – Air Methods Corporation

*General*

The Air Methods Corporation helicopter, N407GA, was destroyed by a post impact explosion and fire. The helicopter impacted terrain subsequent to the mid-air collision. Burned vegetation and trees surrounded the wreckage. The helicopter came to rest upright, with the fuselage oriented on an approximate magnetic heading of 060 degrees.

The fuselage, engine, main rotor transmission, and rotor mast were involved in the post accident fire. The engine, transmission, and rotor mast were positioned to the right of and adjacent to the main fuselage. The aft fuselage and tail boom were separated from the main wreckage. They came to rest about 15 feet east of the fuselage, and were oriented approximately 90-degrees relative to the main fuselage orientation. The aft fuselage exhibited damage consistent with the post impact fire, with the damage decreasing aft. The tail boom itself did not exhibit fire damage.

*Fuselage*

The cockpit, cabin, and aft fuselage were discolored and soot covered consistent with the effects of a post impact fire. The fire had consumed the top and sides of the fuselage, and the cockpit and cabin areas were exposed. The aircraft also exhibited damage consistent with impact forces. A section of the lower right fuselage nose, including the pitot tube, was separated from the remainder of the fuselage. It came to rest in the debris path about 150 feet southeast of the main wreckage.

The flight controls were damaged consistent with impact forces and post impact fire. The cyclic and collective controls were present in the cockpit area. Both were separated at the base fittings. The throttle was in the “Fly” position when observed at the accident site. The splines at the base of the collective appeared intact. Co-pilot controls were not installed. The cyclic and collective control tubes in the cockpit floor area appeared intact to the base of the vertical tunnel. Within the vertical tunnel (broom closet), the flight control tubes were fractured in a manner consistent with overload failures. Control tube rod ends were also bent and fractured.

The main rotor servo actuators remained partially attached to the bulkhead at the top of the vertical tunnel. The units were damaged consistent with impact forces and were discolored due to involvement in the post impact fire.

The on-board medical oxygen bottle was observed in two pieces. An end fragment came to rest about 75 feet northeast of the fuselage. The second piece, which contained the valve and pressure gauge, remained with the fuselage. Both pieces exhibited discoloration and sooting consistent with fire damage.

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[1] A more detailed wreckage description is contained in the Airworthiness Group Field Notes associated with this accident.

[2] Directions related to accident site placement and component damage/deformation are with respect to an intact airframe unless otherwise noted.

*Main Rotor System*

The main rotor blades remained attached to their respective yoke flexures on the main rotor hub. The rotor hub, mast, and main transmission, with the transmission mount attached, came to rest as a unit, adjacent to the fuselage. The main rotor blades were deformed. The components exhibited sooting and discoloration consistent with involvement in the post impact fire. The main rotor transmission mount was fractured along the left, aft support. The remaining supports were deformed, but they did not appear fractured.

The pitch change links were fractured, with the appearance of the fracture surfaces consistent with overload failure. The opposing pitch change link rod ends remained attached to the rotating swashplate, with the exception of one of the links. One swashplate attachment arm was separated, along with the mating portion of the pitch change link. The non-rotating portion of the swashplate appeared intact. The control links remained attached to the swashplate at the rod ends; however, the links themselves were fractured.

The main transmission was intact. Partial rotation of the main drive shaft produced corresponding rotation of the main rotor mast. The main drive shaft was fractured aft of the transmission. The K-flex coupling between the drive shaft and the transmission remained intact. The K-flex coupling at the aft end of the first drive shaft segment was fractured. Appearance of the fracture surfaces was consistent with overload failures. Rotational continuity was observed between the main rotor and tail rotor drive shafts, through the engine gearbox and freewheeling unit.

The four main rotor blades remained attached to the yoke flexures at the rotor mast. The blade bolts appeared intact and properly installed. All four blades exhibited fire damage at the inboard ends of the blades. The blades were arbitrarily numbered 1 through 4 for identification purposes. The corresponding color designation of the blades could not be determined due to the fire damage.

Blade 1 exhibited discoloration and delamination along the inboard approximately 4-1/2 feet of the blade. Blue and red chordwise marks consistent with paint transfer were observed on the leading edge over an approximate length of 5 inches. Blade 2 sustained impact and thermal damage. Blue chordwise marks consistent with paint transfer were observed on the leading edge, approximately 2 inches in length. The inboard 5-1/2 feet of the leading edge abrasion strip was separated from the blade and recovered about 150 feet south of the fuselage. Blade 3 exhibited fire damage along the entire length of the blade. Identification of any leading edge transfer marks was precluded by the fire damage. Blade 4 exhibited fire damage along the entire length of the blade; with the exception a section about 3 feet in length near mid-span. The blade root hub was discolored but appeared intact. Discoloration due to fire damage prevented identification of any leading edge transfer marks.

*Engine*

The engine came to rest adjacent to the main rotor mast and the fuselage. The entire engine was discolored consistent with involvement in the post-impact fire. The compressor impeller was intact; however, several impeller blades exhibited leading edge nicks and gouges. Abrasion and scrape marks were observed on the compressor support. The power turbine and gas producer sections appeared intact. The combustion housing

and engine exhaust stack were deformed. The engine gearbox housing was intact, with the exception of a section approximately 2 inches square.

The Engine Control Unit sustained damage consistent with a fire. In addition, the unit housing was fractured in several places exposing the components. The unit was retained for further examination. (A summary of this examination is included later in this report.)

*Tail Boom/Tail Rotor*

The tailboom and a section of the aft fuselage separated from the remainder of the airframe. The tailboom remained securely attached to the aft fuselage segment. As noted previously, this structure came to rest approximately 15 feet east of the fuselage and was oriented about 150 degrees magnetic. The aft fuselage section and forward portion of the tailboom exhibited discoloration consistent with fire damage. The remainder of the tailboom did not exhibit any thermal damage.

The tailboom was fractured about 21 inches aft of the tailboom-to-fuselage attachment point. The skin was buckled adjacent to the fracture. The aft fuselage section came to rest on its right side. The tail boom aft of the fracture came to rest upright. The tail rotor drive shaft and pitch control rod were continuous across the fracture. However, the tail rotor pitch control rod was bent in the vicinity of the fracture.

The remainder of the tailboom was intact, including the tail rotor drive shaft, transmission, and pitch change links. However, the forward flange of one driveshaft segment was fractured. Rotation of the drive shaft aft of the fractured flange produced a corresponding rotation of the tail rotor blades, without binding. Both tail rotor blades remained attached to the hub. One blade exhibited an area of skin delamination near the trailing edge about mid-span consistent with impact damage. Otherwise, the blades exhibited only minor abrasions and scratches.

The vertical fin stabilizer separated from the aft end of the tailboom at the attachment screws. It came to rest immediately adjacent to the tail boom consistent with separation at the time of impact. The right horizontal stabilizer and end cap were separated from the tailboom about 7 inches outboard of the tailboom. The separated portion of the horizontal stabilizer and end cap came to rest adjacent to the tailboom. The left horizontal stabilizer remained securely attached to the tail boom. The upper and lower sections of the end cap were separated from the stabilizer, and from each other, at the outboard end of the horizontal stabilizer. Both end cap sections were recovered from the debris path.

*Landing Gear/Skids*

All landing gear (skid) components came to rest with the main wreckage, and were lying in proper position relative to the airframe. Both skids were fractured. The landing gear crosstubes were deformed downward (flattened) on both the left and right sides. The extent of deformation was greater on the right side consistent with a right side low, vertical impact.

**N407MJ – Classic Helicopter Services**

*General*

The Classic Helicopter Services helicopter, N407MJ, was destroyed due to the mid-air collision and subsequent in-flight collision with trees and terrain. No fire damage was observed on the Classic Aviation helicopter.

The main wreckage consisted of the fuselage, engine, transmission, and main rotor hub and blades. Three trees located approximately 35 feet east of the fuselage were broken off approximately 25 to 40 feet above ground level. Multiple tree branches and limbs exhibiting fresh breaks were located on the ground in the vicinity of the fuselage. The tail boom was separated from the fuselage. It came to rest about 73 feet east of the fuselage.

*Fuselage*

The fuselage was fragmented into three sections. The forward (cockpit) section came to rest inverted, nose down at an angle of about 45-degrees relative to the terrain against two trees. The mid (cabin) section of the fuselage was separated from the forward section. It came to rest on its left side adjacent to the forward section. The engine, main rotor transmission, and rotor mast were also on their left side, in position relative to the mid (cabin) section. The aft fuselage section came to rest on its left side, nearly inverted, against a tree. A 12-inch section of the tail boom remained attached to the fuselage. The fuselage nose was crushed aft. The left side of the fuselage was separated completely, exposing the cockpit and forward cabin areas.

The flight controls were damaged consistent with impact forces. The cyclic and collective controls were present in the cockpit area. Both were separated near the base. Co-pilot controls were not installed. The cyclic and collective control tubes in the cockpit floor area appeared intact to the base of the vertical tunnel. The control tubes within the vertical tunnel (broom closet) were bound but appeared otherwise intact. Control tube rod ends were intact. The anti-torque pedals were present. The control rod was severed about 6 inches inboard of the bellcrank. The rod end remained attached.

The main rotor servo actuators remained attached to the bulkhead at the top of the vertical tunnel. The units were damaged consistent with impact forces. The control rods were bent but appeared otherwise intact.

*Main Rotor System*

The main rotor blades remained attached to the rotor hub. The rotor hub, mast, and transmission remained secured to the fuselage roof beam structure by the transmission mounts. They came to rest with the engine and the remainder of the fuselage.

The transmission housing and mounts appeared intact. The main drive shaft segment remained securely attached to the transmission at the K-flex coupling. The main drive shaft segment was intact, but it exhibited circumferential scoring along its length. The K-flex coupling at the aft end of the shaft was fractured in a manner consistent with overload. The transmission exhibited continuity through the unit. Rotation of the forward end of the main drive shaft produced corresponding rotation of the main rotor mast.

The main rotor mast, blade mounting yokes, and pitch change horns appeared intact. One pitch change link was intact. The remaining three pitch change links were fractured. The ends of the links were still attached to the horns and rotating swash plate via the rod ends, with one exception. One clevis on both the rotating and non-rotating halves of the swash plate was fractured. Appearance of the fracture surfaces on the swash plate and the pitch change links was consistent with overload failures. Flight control linkage to the non-rotating portion of the swash plate remained attached and was intact. One control rod was deformed. The support brackets common to the linkage bellcranks were fractured.

The four main rotor blades remained attached to the yoke flexures at the rotor mast. The blade bolts appeared intact and properly installed. The blades were arbitrarily numbered 1 through 4 for identification. The corresponding color of each blade is also included for reference.

Blades 1, 2 and 3 were fragmented, dented and deformed consistent with impact damage. The tips of these three blades had separated and were recovered in the accident debris path. Blade 1 (blue) exhibited blue paint transfer marks over a 5-1/2 inch length. In addition, green and white paint transfer was observed near the leading edge. Blade 2 (orange) exhibited a 3-inch wide area of white paint transfer marks along the leading edge of the blade. Chordwise scratches were also observed. Blade 3 (red) exhibited white paint transfer marks over a 3-inch wide area, and chordwise scratches on the upper and lower surfaces near the area of paint transfer. Blade 4 (green) was intact; however, the blade exhibited leading edge denting. Blue paint transfer was observed on the upper and lower surfaces of the leading edge over a 7-inch width.

*Engine*

The engine remained secured to the airframe by the engine mounts. It came to rest in a partially inverted, forward (inlet) end downward orientation. The forward engine mount was intact. The aft engine mount was separated from the airframe and deformed. The compressor impeller disc was intact; however, the blades exhibited leading edge gouges. Scrape marks were observed on the compressor front support consistent with impeller rotation at the time of impact. The impeller disc exhibited resistance and binding when rotated by hand. Continuity to the starter-generator was observed during rotation. The turbine wheel appeared intact. The turbine wheel rotated and exhibited continuity to the output shaft.

*Tail Boom/Tail Rotor*

The tail boom separated from the airframe about 12 inches aft of the tail boom-to-fuselage joint. It came to rest about 73 feet east of the fuselage. The forward 12-inch section of the tail boom remained attached to the fuselage. The skin was deformed, twisted and torn at the separation point.

The tail rotor gearbox, and vertical fin stabilizer had separated from the aft end of the tail boom. They came to rest adjacent to the tail boom. The pitch control linkage remained attached to the gearbox. The tail rotor gearbox appeared intact. The tail rotor mast and tail rotor blades remained attached to the gearbox. The gearbox exhibited continuity when the rotor mast or input drive shaft was rotated. The pitch control links were bent but appeared otherwise intact, and the pitch control mechanism appeared functional.

The tail rotor drive shaft segment immediately forward of the transmission[3] (#1) remained attached at the flexible Thomas coupling; although the coupling was fractured. The forward end of the drive shaft exhibited rotational scoring. Two drive shaft segments (#2 and #3) remained attached to the tail boom. They were bent and dented. The forward drive shaft segments (#4 and #5) had separated from the mating segments.

Both tail rotor blades remained secured to the tail rotor hub assembly and mast. One tail rotor blade exhibited leading edge crushing damage over the inboard portion of the blade, and deformation along the outboard trailing edge. Blue and red paint transfer marks were observed on the face of the blade and on the trailing edge near mid-span. Black transfer marks were observed on the leading edge near mid-span. The second tail rotor blade exhibited leading crushing damage over approximately the inboard one-half span of the blade. Blue paint transfer was observed in this area. The inboard 5-1/2 inches of the blade leading edge exhibited black transfer marks.

The horizontal stabilizers and end caps were fragmented. The outboard two-thirds of the right horizontal stabilizer had separated from the airframe. The remaining inboard portion of the assembly remained securely attached to the tail boom. The separation was oriented forward-aft, parallel to the longitudinal axis of the aircraft. The right end cap was intact and remained securely attached to the separated section of the horizontal stabilizer.

The left horizontal stabilizer was separated into three fragments. The inboard section remained attached to the tailboom. This section was approximately 18-inches in length at the leading edge and oriented at a 27-degree angle relative to the longitudinal axis of the aircraft. The second fragment of the left horizontal stabilizer was about 6-inches in length. The stabilizer exhibited a distinct upward bend adjacent to the fracture surface consistent with an impact from below. The third fragment consisted of the remainder of the stabilizer, with the end cap attached. Additionally, a section of the left end cap was separated from the remainder of the assembly. The fragment consisted of the upper-aft portion of the end cap, above the horizontal stabilizer. The skin adjacent to the separation was bent inboard.

The horizontal stabilizer and end cap fragments were distributed along the top edge of the embankment in the vicinity of the Air Methods aircraft.

The tailboom exhibited a cut through the lower skin in the area below the horizontal stabilizer. This cut was oriented at an approximate angle of 38 degrees relative to the longitudinal axis of the aircraft. The carry-through structure of the horizontal stabilizer was deformed upward but appeared otherwise intact. This deformation continued to the inboard portion of the horizontal stabilizer. The horizontal stabilizer vane had separated from the airframe; however, it also was deformed consistent with the adjacent damage.

[3] This report references tail rotor drive shaft and hanger bearing numbers as beginning from the aft end of the tail boom. Drive shaft segment #1 is connected to the tail rotor gearbox at the aft end. Drive shaft segment #4 is connected to the oil cooler blower assembly on the forward end. Hanger bearings #1 through #4 are installed on the tail boom. Hanger bearings #5 and #6 are installed on either side of the oil cooler blower assembly on the main fuselage.

The tail boom was creased on the left side at the forward end near the separation from the fuselage. It was oriented upward at an angle of about 37 degrees relative to the ground reference. The forward portion of the deformation exhibited blue transfer marks. The skin was torn through along an approximate 1-inch length at the lower-forward end of the crease. The crease was sharp and distinct at the lower-forward end, and became shallower as it progressed upward and aft.

*Landing Gear/Skids*

The landing skid assembly separated from the airframe and was located adjacent to it at the accident site. The right skid was intact. The left skid was fractured at two locations between the forward and aft crosstube saddles. The forward cross tube was fractured above both the left and right saddles. Both the left and right steps had separated from the cross tube legs. The left leg of the aft crosstube was deformed inboard about 60 degrees. Both the forward and aft crosstube legs on the right side of the aircraft were deformed outboard approximately 30 degrees. Fracture surfaces were consistent in appearance with overload failures.

## F. AIRCRAFT INFORMATION

### Air Methods Corporation – N407GA

The aircraft operated by Air Methods Corporation, N407GA, was a 1997 Bell Textron Canada Model 407 helicopter, serial number 53104. It was powered by a Rolls-Royce/Allison Model 250B-C47B turbo-shaft engine, serial number CAE847119. The aircraft was certificated under Federal Aviation Administration (FAA) type certificate H2SW.

The aircraft was initially registered with Transport Canada under Canadian registration number C-FSPD. It was subsequently imported to the United States and purchased by Air Methods Corporation on January 23, 1998. The helicopter was registered with the FAA as N407GA and issued an airworthiness certificate on February 8, 1998. Ownership of the aircraft was transferred to Flagstaff Medical Center (dba Guardian Air) on February 18, 1998. Flagstaff Medical Center was the owner of record at the time of the accident.

The aircraft was configured for emergency medical service (EMS) operations. The interior configuration consisted of a pilot position on the right side of the aircraft. A patient litter (stretcher) was installed on the left side of the helicopter, running from the forward area of the cockpit (next to the pilot) to near the aft end of the cabin. A short partition about 14 inches in height was positioned between the pilot seat and the forward end of the stretcher, in the cockpit area. Two forward facing seats for medical crewmembers were located on the left and right sides at the aft end of the cabin. Medical equipment was installed/stored in the forward-center area of the cabin. An additional rearward-facing seat was positioned behind the pilot, in the mid-cabin on the right side of the aircraft.

According to the operator’s maintenance records, the accident helicopter had accumulated 9,372.6 hours total flight time as of the day of the accident. The engine had accumulated 9,112.0 hours, which was comprised of 19,635 start cycles.

The helicopter was maintained under an FAA Approved Aircraft Inspection Program (AAIP). The most recent progressive phase inspections were completed on June 21, 2008. The inspections consisted of event 4, event 10, and event 21 procedures as outlined in the AAIP. The records indicated that the operator had complied with all applicable FAA Airworthiness Directives (AD). In addition, the maintenance records contained no significant maintenance action / discrepancies within 30 days of the accident.

**Classic Helicopter Services – N407MJ**

The aircraft operated by Classic Helicopter Services, N407MJ, was a 1996 Bell Textron Canada Model 407 helicopter, serial number 53079. It was powered by a Rolls-Royce/Allison Model 250B-C47B turbo-shaft engine, serial number CAE847227. The helicopter was certificated under FAA type certificate H2SW.

The aircraft was exported to Brazil after initial delivery. It was subsequently imported to the United States in January 2004, and registered by the FAA as N407HB. FAA airworthiness and registration certificates were issued on January 29, 2004. The aircraft was purchased by M & J Leisure L. C. on March 30, 2004, and assigned FAA registration number N407MJ. M & J Leisure L. C. was the owner of record at the time of the accident.

The aircraft was configured for emergency medical service (EMS) operations. The interior configuration consisted of a pilot position on the right side of the aircraft. A patient litter (stretcher) was installed on the left side of the helicopter, running from the forward area of the cockpit (next to the pilot) to near the aft end of the cabin. A short partition about 14 inches in height was positioned between the pilot seat and the forward end of the stretcher, in the cockpit area. Two forward facing seats for medical crewmembers were located on the left and right sides at the aft end of the cabin. Medical equipment was installed/stored in the forward/right side area of the cabin, behind the pilot.

According to the operator's maintenance records, the accident helicopter had accumulated 4,540.3 hours total flight time as of the day of the accident. The engine had accumulated 6,025.8 hours, which was comprised of 7,025 cycles.

The helicopter was maintained in accordance with the Bell Helicopter maintenance schedule. The most recent progressive inspection was completed on June 19, 2008. The inspection consisted of an event 3 procedure as outlined in the maintenance schedule. The records indicated that the operator had complied with all applicable FAA Airworthiness Directives (AD).

The maintenance records noted that the engine was replaced on June 27, 2008, due to cracking found on the exhaust gas collector. The aircraft had been flown 2.0 hours with the replacement engine prior to the day of the accident. On June 25, 2008, the tail rotor yoke assembly was replaced because the feathering bearings were loose. The aircraft had been flown 5.2 hours since that work was completed. No other significant maintenance action or discrepancies were recorded during the 30-day period prior to the accident.

## F. SUMMARY OF ENGINE CONTROL UNIT (ECU) EXAMINATIONS

### General

The engine control unit (ECU) had the capability to store real-time data related to engine operating parameters, fault history, and abnormal engine condition (incident) information. System anomalies were recorded as Last Engine Run Faults, Accumulated Faults, and Time Stamped Faults. Last Engine Run Faults represented a record of fault conditions detected during the most recent engine run only. Accumulated faults comprised a record of faults recorded by the unit since the memory was last cleared. This included last engine run faults. Time Stamped Faults contained an accounting of recent fault and exceedance detections, with the associated engine operating time parameter.

An Incident Recorder monitored a set of engine control parameters for abnormal conditions. In the case that an anomaly or incident was detected, the recorder provided for 12 seconds of pre-incident data (10 data sets), and 48 seconds of post-incident data (40 data sets) to be written to non-volatile memory.

### Air Methods Corporation – N407GA

The ECU recovered from N407GA was model number EMC-35A, serial number JG8ALK0554. The unit exhibited impact and thermal damage. Partial disassembly of the unit revealed extensive damage to the components containing the non-volatile memory. As a result, no data could be extracted from the unit.

### Classic Helicopter Services – N407MJ

The ECU recovered from N407MJ was model number EMC-35A, serial number JG0ALK0653. It had sustained damage consistent with impact forces. Internal damage to the unit was minor and extraction of the non-volatile memory was successful.

Engine history data noted an ECU operating time of 3,556.53 hours and an engine run time of 1,374.80 hours. The ECU operating time represents the cumulative time that electrical power had been applied to the unit. Maintenance personnel cannot access this parameter. The engine run time is incremented when the engine is actually running. Maintenance personnel normally set this parameter at installation.

The data contained a power turbine speed ($N_p$) exceedance that occurred at an engine run time of 1371:01:18.216. The exceedance lasted for 0.96 seconds and reached a peak value of 103.09 percent. A turbine speed in excess of 102.1 percent triggers an exceedance event. According to the ECU manufacturer, $N_p$ parameter values in excess of the limit are not uncommon due to occasional flight operations such as quick landings or descents, and do not necessarily indicate any system or operational anomalies.

The ECU incident recorder contained two events. The first occurred at 1374:54:52.896 and was triggered by a loss of rotor speed below 92 percent. The actual rotor speed recorded during the event was 86 percent. The second event occurred at 1374:54:53.208 and was associated with a torque rate sensor exceedance. A sensor exceedance is generated when the sample-to-sample change exceeds 1,500 percent per second. This event was partially recorded in the history data. According to the ECU manufacturer, the absence of an associated timestamp was possibly because electrical

power was removed from the unit at the time the data was being written into non-volatile memory.

The incident recorder function in the ECU provided 10 data sets prior to the incidents and 40 data sets after, for a total of 50 data sets. However, only records 3 through 11 contained any data. The absence of data on records 1 and 2 was likely due to an interruption of electrical power before the information could be transferred into non-volatile memory. A loss of power to the ECU also likely caused the absence of data on records 12 through 50.

The data indicated that the engine control system was in Auto mode with no indication of a fault condition prior to the initial event. After the two events, the data indicated the ECU was operating in a degraded condition due to the confirmed senor fault.

## G. SUMMARY OF RADIO EXAMINATIONS

### General

The communications radios were removed from both aircraft in an attempt to retrieve the frequencies selected at the time electrical power was interrupted. Both aircraft were equipped with Bendix/King radios for communication and navigation on assigned aviation frequency ranges. The Bendix/King radios are designed to hold two frequencies. One is denoted as “Use” and the other is denoted as “Stby”. The in-use (“Use”) frequency is active for receiving and transmitting. The standby (“Stby”) frequency can be exchanged with the in-use frequency by depressing the button on the bezel.

In order to support the EMS mission, the aircraft were also equipped with multi-band transceivers for communication with ground based police, fire, and emergency medical personnel. The multi-band radios had the capability to communicate on VHF/UHF FM frequency bands.

### Air Methods – N407GA

The two aviation radios recovered from N407GA were both Bendix/King KX165 Nav-Comm’s (p/n 069-1025-25 / s/n 60021 and 65129).

The KX165 (s/n 60021) exhibited impact and thermal damage. The faceplate was removed and a new one installed on the accident unit. When powered up the unit displayed the communications in-use frequency as 134.55 and the standby frequency as 122.75. The navigation in-use frequency was 113.85 and the standby frequency was 108.75. The transmit and receive functions of the unit tested within specifications. The transmission power when tested was 15 watts. The manufacturer’s specification was 10 watts minimum.

The KX165 (s/n 65129) also exhibited impact and thermal damage. The faceplate was removed and a new one installed on the accident unit. When powered up, the unit displayed the communications in-use frequency as 123.02 and the standby frequency as 136.87. The navigation in-use frequency was 116.90 and the standby

frequency was 113.80. The transmit and receive functions of the unit tested within specifications. The transmission power tested within specifications at 15 watts.

The multi-band radio system was comprised of Global/Wulfsberg RT-138F and RT-406F FM transceivers, paired with a Northern Airborne Technologies TH-250 radio control head. The selected frequencies were retained in the control head unit and not in the transceivers.

The radio control head sustained impact and thermal damage. Examination of the component determined that the unit was set to power-up on specific preset frequencies, and not necessarily the frequency set at the time it was powered down. The component was set to power-up on channel 031 for RT#1 and channel 047 for RT#2. However, the manufacturer noted that the transceiver type retrieved from the unit was incorrect for a Flexcomm interface. This may be an indication that the memory circuits were damaged to some extent.

**Classic Helicopter Services – N407MJ**

The aviation radios recovered from N407MJ were a Bendix/King KX165 Nav-Comm (p/n 060-1025-25 / s/n 58421) and a KY196A Comm (p/n 064-1054-30 / s/n 8345).

The KX165 (s/n 58421) sustained impact damaged and could not be powered up directly. The electronic component containing the non-volatile memory was removed and installed into a host radio unit. When powered up, the host unit displayed the communications in-use frequency as 125.30 and the standby frequency as 122.80. The navigation in-use frequency was 117.60 and the standby frequency was 108.40.

The KY196A (s/n 8345) had sustained minor damage. The unit was connected to an electrical harness and powered-up in the as-received condition. The in-use frequency displayed was 134.55 and the standby frequency was 120.62. The transmit and receive functions of the unit tested within specifications. The transmission power tested within specifications at 20 watts.

The multi-band radio system consisted of a Technisonic Industries Ltd. Model TFM-500 unit (s/n JA1563). The unit exhibited impact damage to the faceplate and the forward printed-circuit boards. The damaged faceplate was replaced and power was applied to the unit. Examination of the radio determined that the unit was set to display the most recently tuned frequencies at each power-up sequence. Functional testing of the VHF and UHF bands was normal, and no mechanical anomalies were observed. The frequencies displayed upon power-up were:

| | | | | |
|---|---|---|---|---|
| Display line 1 (VHF) – | 023 | GARFCORPT | 156.0150RT | |
| Display line 2 (UHF) – | 001 | CLASSIC1 | 463.6250RT | |
| Display line 3 – | GD1 | NPS Guardn | 171.6250RX | |
| Display line 4 – | BS | VHF TONE | OFF | PWR-HI |

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**N407GA (Air Methods) – Accident Site to Flagstaff Medical Center**

**N407GA (Air Methods) – Accident Site**

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**N407GA (Air Methods) – Left Horizontal Stabilizer End Cap (Bell Photo)**

**N407MJ (Classic Helicopters) – Main Wreckage**

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## -- Report Photos --

**N407MJ (Classic Helicopters) – Tail Boom**

**N407MJ (Classic Helicopters) – Tree Strikes Leading to Wreckage Site**

## -- Report Photos --

**N407MJ (Classic Helicopters) – Tail Boom Layout (Upright)**

**N407MJ (Classic Helicopters) – Tail Boom Layout (Inverted)**

## -- Report Photos --

**N407MJ (Classic Helicopters) – Tail Boom Damage**

**N407MJ (Classic Helicopters) – Tail Boom Layout Damage**

## -- Report Photos --

**N407MJ (Classic Helicopters) – Main Rotor Blade (Paint Transfer)**