AMERICAN EUROCOPTER
AN EADS NORTH AMERICA COMPANY

Accident Investigation Summary
(Updated January 30, 2012)

I. ACCIDENT INFORMATION

NTSB Accident #: CEN11FA599
Aircraft Model & S/N: Eurocopter AS350 B2, S/N 3728
Aircraft Registration: N352LN
Operator: Air Methods Corporation
Location: Mosby, Missouri
Date: August 26, 2011
Time: 1841 CDT

II. HISTORY OF FLIGHT (NTSB Preliminary Report)

On August 26, 2011, at 1841 central daylight time (all times CDT), a Eurocopter AS-350-B2 helicopter, N352LN, sustained substantial damage when it impacted terrain during an autorotation following a loss of power near the Midwest National Air Center (KGPH), Mosby, Missouri. The pilot, flight nurse, flight paramedic, and patient received fatal injuries. The emergency medical services (EMS) equipped helicopter was registered to Key Equipment Finance, Inc., and operated by Air Methods Corporation, doing business as LifeNet in the Heartland. The 14 Code of Federal Regulations Part 135 medical flight departed from the Harrison County Community Hospital, Bethany, Missouri, about 1811, and was en route to KGPH to refuel. After refueling, the flight intended to depart and land at Liberty Hospital in Liberty, Missouri, which was located about 7 nautical miles (nm) from KGPH on a 235 degree heading. Visual meteorological conditions prevailed at the time of the accident, and a company visual flight rules (VFR) flight plan was filed.

The purpose of the air medical inter-facility transport flight was to transport a patient from the Harrison County Community Hospital to Liberty Hospital. The request was received by the company's communication center at 1719 and the pilot was notified at 1720. At 1730, the pilot reported to the communication center that he departed from the helicopters base at Rosecrans Memorial Airport (KSTJ), in St. Joseph, Missouri. He reported that he lifted off with two hours of fuel and 3 persons onboard and was en route to Bethany, Missouri. Approximately 28 minutes later, at 1758, the helicopter landed at the Harrison County Community Hospital helipad to pick up the patient.

While the helicopter was shut down on the helipad, the pilot contacted the company's communication center by telephone and notified them that about half way through the flight from KSTJ, he realized that he did not have as much fuel onboard as he originally thought. After a discussion about possible fueling and re-routing options, the pilot elected to stop en route at KGPH for fuel, and then proceed to the Liberty Hospital helipad to drop off the patient. The person, who was providing flight following to N352LN at the company's communication center, informed the pilot that Liberty Hospital was 62 nm, and that KGPH was 58 nm distant, respectively.

About 1811, the flight departed from the Harrison County Community Hospital helipad. About a minute later, the pilot contacted the company's communication center and reported that he had 45 minutes of fuel and 4 persons onboard and was en route to KGPH. He asked the flight follower at the company's communication center to contact the fixed base operator at KGPH to let them know that the helicopter was inbound for fuel. At 1841, the helicopter impacted a farm field about 1.7 nm miles north-northeast of KGPH. There was no post impact fire.

At 1754, the surface weather observation at the Charles B. Wheeler Downtown Airport (KMKC), Kansas City, Missouri, located about 21 nm southwest of the accident site, was: wind 110 degrees at 6 knots, 10 miles visibility, clear sky, temperature 31 degrees Celsius, dew point 13 degrees Celsius, and altimeter 29.96 inches of Mercury.

III. AIRCRAFT INFORMATION

The accident aircraft was a Eurocopter AS250B2 helicopter, manufactured as serial number 3728 by Eurocopter France in 2003. According to the FAA aircraft registry, the helicopter received its FAA normal-standard airworthiness certificate on February 6, 2004 and was registered as N352LN to Key Equipment Finance Inc. on March 30, 2005.

The Eurocopter AS350B2 is powered by a single Arriel 1D1 free turbine engine. The helicopter is equipped a three blade main rotor system which rotates clockwise (when looking from above), a conventional tail rotor, and skid type landing gear.

The accident helicopter was equipped with an Air Methods EMS Interior, which was configured with the pilot seat in the front right position, three medical crewmember seats mounted on the aft cabin bulkhead facing forward, and one patient litter oriented longitudinally on the left side of the cabin.

According to the aircraft daily flight logs, the aircraft had accrued a total time of 3,655 hours 10 minutes. Please see FAA Maintenance Summary for additional details concerning the maintenance history of the aircraft.

IV. WRECKAGE EXAMINATION

The aircraft wreckage debris path was located in a farm field, and oriented on a heading of approximately 250°, on a direct path towards KGPH from the Bethany County Community Hospital helipad. Please see AEC Wreckage Diagram for additional details.

The aircraft structure was heavily fragmented and scattered along the debris path (approximately 100 feet in length). All the impact signatures were consistent with a low RPM and a high rate of descent. The impact signatures to the components of the airframe structure were consistent with the initial impact occurring in a nose-low and

slight left-bank attitude, oriented opposite the direction of travel. An approximate 2-foot section of the lower right windscreen was found embedded 10 inches deep at the initial impact point at an 80 degree angle, which corresponds to an approximate nose down aircraft attitude of 40 degrees. The fuselage was broken open separating the patient litter and three rear seats from the aircraft. The pilot's 'Sicma' energy attenuating seat remained attached to the floor mounts and exhibited a near full attenuation and slight displacement to the left; approximately 8 inches of the top of the seat, head rest portion was broken and separated aft. The four point restraints for the aft left and aft right seats were still clasped together and cut by first responders. Similarly for the pilot's restraint system, was still clasped together and cut by first responders.

Three separate main rotor blade strike ground scars were found at the beginning of the wreckage path, to the right of center. The main rotor blades remained attached to the rotor head and mast. Due to the post impact vaulting of the wreckage along the energy path, one blade (blue) came to rest bent down and inward more than 90° in a flapping fashion at the root, the other two blades were relatively straight.

The tail section (including the tail rotor drive shaft and pitch change tube) was separated from the main fuselage at the forward tail cone bulkhead. The left horizontal stabilizer was damaged with impact bending aft and down approximately 90°; almost no damage was observed to the right horizontal stabilizer. The tail rotor blades were damaged with inboard flapping fracture damage at the hub; with both blades making a penetrating contact to the vertical and dorsal fin. The tail rotor gear box (on the left side) displayed a ground impact signature that crushed the fairing around the gearbox with a down and aft force.

The engine to tail rotor drive shaft coupling exhibited bending consistent with tension and some rotation. The short forward tail rotor drive shaft was disengaged from the longer aft tail rotor drive shaft at the spline fitting. Minor flailing damage was observed on the interior of the cowling. Tail rotor continuity was confirmed, as it rotated freely when this investigator manually turned the tail rotor drive shaft and observed the blades travel 360° of travel. Tail rotor pitch change continuity was confirmed to each blade by the actuation of the pitch change arm at the rotor hub aft. The rubber grommet cap over the oil filler screen was found damaged with the cap split opened displaying the oil screen full with a foreign substance similar to the constancy of dirt and oil; this was retained by the NTSB IIC and confirmed as such by their lab analysis.

The main transmission was found attached to the aircraft structure and relatively intact and attached to the engine and the rotor mast assembly. The main rotor head rotated freely, with the corresponding with main transmission shaft. The main rotor drive shaft was still connected at both (fwd and aft) flex couplings, which exhibited some distortion. All the hardware was intact and secured.

The 'Starflex' remained in the center of the rotor hub; however, two of the star arms' were broken mid-span (yellow and red), and the blue star arm remained attached.

The fuel tank was intact and located in the midst of the main wreckage. No fuel was observed at the accident site; approximately less than 1 liter of fuel was found in the fuel system tank or lines (which were generally intact). The airframe fuel filter system was removed from the airframe by the investigative team for inspection; no fuel was observed in the lines on the engine side of the filter, only a residual amount of fuel was observed in the lines on the tank side of the filter. When the quick drain sump was depressed, at the bottom of the filter bowl, no fuel was observed. No fuel was seen in the sight glass. The fuel quantity gage was removed from the wreckage and retained by the NTSB IIC for future examination.

The instrument panel was relatively intact, and separated from the airframe; however, attached to the wreckage structure predominantly by wiring and cabling. Most instruments could be easily read and observed; many reading displayed settings towards the low side of measurements; however, the overall impact damage precluded the ability to rely on certainty for their readings. Note: the instrument panel was configured with the Night Vision Goggle (NVG) lighting and filters. The brightness switch on the caution-warning annunciator panel was found on the low (dim) setting.

The collective control was found in the full down position albeit was heavily damaged and separated from the structure of the aircraft along with the throttle quadrant area (i.e. the rotor brake, fuel flow control, and fuel shut-off control lever). The fuel-shut off control was full forward/down and the safety wire was still in place. The rotor brake handle was stowed; however the actual rotor brake (at the hub) was engaged due to the tension on the control cable lines. The fuel flow control lever was in the flight position and bent down to the left approximately 90° from impact. The fuel flow control lever handle and start button was separated. The hydraulic test switch on the collative control was in the normal position

The cyclic control yoke was full forward, the friction lock was tight (could not be loosened by this investigator); the base of the cyclic control yoke tube was damaged with a lateral pinch in the tubing.

All the hydraulic servo actuators were accounted for and relatively intact and attached to the rotor control system. The poly-v hydraulic drive belt and pump assembly remained intact. The hydraulic manifold was intact, and the clogging indicated was extended, likely due to impact forces.

Both the cyclic and collective push-pull control tubes were crushed and separated with angular fracture surfaces before and after the mixing unit junction to the rotor hub assembly.

The engine, fuel tank assembly, fuel gauge, and caution-warning annunciator panel, were retained and shipped to American Eurocopter in Grand Prairie, Texas. An examination of these components will take place at on later date at American Eurocopter and Turbomeca USA.

V. FUEL SYSTEM COMPONENT EXAMINATION

The subject aircraft's fuel tank was partially separated from the airframe during the impact sequence and found to be relatively undamaged. At the final resting position of the main wreckage the tank was situated in the middle of the fragmented airframe structure. The tank itself was oriented on its right side with the forward and top half of the tank down, towards the ground. No fuel was observed in the tank, and no fuel smell was noted at the mishap site by the investigative team members or by the first responders to the accident scene. The investigative team removed the tank from the wreckage and sealed the tank's vent, filler, and drain ports with scrim-backed pressure sensitive tape for shipping.

The aircraft's fuel quantity gage instrument had been found loose behind the instrument panel, separated from its panel mounted position. The gage was visually inspected and exhibited a missing face lens and minor damage from the impact event. The gage was removed from the aircraft and placed in an evidence bag for shipping.

The aircraft's (4 Alpha) caution-warning annunciator panel was found intact and still attached to the cockpit instrument panel, equipped with a Night Vision Goggle (NVG) face plate lenses (P/N: 350A61 184022/7); the Day/Night dim switch was in the "dim" position. The annunciator panel was visually inspected and did not exhibit any visible damage from the impact event. The annunciator panel was removed from the aircraft and placed in an evidence bag for shipping.

The fuel tank and fuel system components (fuel quantity gage, and caution-warning annunciator panel) were shipped to, and retained at, American Eurocopter's secured storage facility in Grand Prairie, TX until this date of examination.

On 10-04-11 this investigator, accompanied by a representative of the FAA Rotorcraft Directorate, removed the electrical plugs (with the lead wires), from the back of the fuel quantity gage and caution-warning annunciator panel units. The electrical plugs and their lead wires were used to build a test set assembly for the subject components. The components, minus the electrical leads, were restored in the secured facility.

On 10-14-11 the investigative party, under the supervision of the National Transportation Safety Board (NTSB) investigator-in-charge (IIC), assembled at the American Eurocopter facility to review, examine, and test the fuel tank assembly and system; the cockpit fuel gauge, and caution-warning annunciator panel.

Findings:

The tape that had been used to seal the tank's vent, filler, and drain ports was removed, and the integrity of the fuel tank and its structure was visually inspected. No damaged was noted to the structure that would have prevented the tank's ability to support a normal capacity of 540 liters (143 gallons) of fuel. The fuel tank was intact with its fuel quantity transmitter probe (located inside), both electric boost pumps, and

its lower drain valve system. The fuel tank was secured to a test stand and leveled for an operational test and functionality. A fuel tank drain plug was installed in the ferry tank connector port. A borescope was used to inspect the inside the empty tank and the capacitance type fuel quantity transmitter located inside the tank; no anomalies were found.

The fuel quantity gage [wiring] was connected to the tank's fuel quantity transmitter probe wiring per the AS350B2 Wiring Diagram Manual schematic.

The caution-warning annunciator panel low "FUEL" warning light [wiring] was connected to the tank's fuel quantity transmitter wiring in accordance to the AS350B2 Wiring Diagram Manual schematic.

According to the AS350 B2 Flight Manual: Section 3.3, (Warning-Caution-Advisory Panel and Aural Warning), Paragraph 2.2 (Amber Lights): the warning caution advisory panel lights are colored "-Red to indicate a failure requiring immediate action, and -Amber to indicate a failure which does not require immediate action." The illumination of the amber light identified as [FUEL] on the Warning-Caution-Advisory Panel indicates a "Fuel quantity less than 60 liters (15.8 US gal)". The 'Pilot Action' is specified to "Avoid large attitude changes" with an additional "Note: Remaining usable fuel allows approximately 18 minutes level flight at maximum continuous power." There are no aural warnings for amber colored caution advisory lights.

The caution-warning annunciator panel and the fuel quantity gage were connected to the fuel tank system. Battery power (26.3 Vdc) was supply to the system. No fuel was in the tank. The fuel quantity gage read 0 % of fuel and the caution-warning annunciator panel low "FUEL" light was illuminated. Fuel was added to the fuel tank at a slow and incremental rate. The fuel quantity gage needle moved off of 0% respectfully as fuel was added to the tank. When the volume of fuel in the tank reached approximately15% (17.7 gallons) the light extinguished. More fuel was added to the tank until the fuel quantity gage reached 20 %; where it was measured to be approximately 27.9 gallons.

The tank's two fuel boost pumps were connected to the battery power supply. When the power was introduced into the circuit both pumps began to operate and the fuel was then drained from the tank. The low "FUEL" light re-illuminated as soon as the fuel was drained to the same level noted earlier on the tank (~17.7 gallons).

For further analysis; the two light bulbs (AO387BP) from the low "FUEL" light segment of the caution-warning annunciator panel were inspected in a cold state, with a 20x video microscope. The filaments of both bulbs exhibited a slightly stretched coil and smaller bend radii in the filament profile at the bulbs support wires when compared to an exemplar light bulb.

All the parts from this testing; including the fuel tank assembly and fuel system, the cockpit fuel gauge, and caution-warning annunciator panel, and wiring were returned

to the American Eurocopter secure storage facility and held for return shipping instructions.

The fuel tank and associated system components were boxed and shipped to Dodson International Parts, Inc., Rantoul, Kansas on Tuesday, November 1, 2011. The FedEx Tracking # for the shipment was 448950055387.

VI. AIRCRAFT AND SIMULATOR FLIGHT DEMONSTRATION

The investigation team requested aircraft and simulator demonstrations of autorotations in various profiles, as well as the correct procedure for a practice (training) autorotation. For the purposes of the investigation, two types of autorotations were discussed:

- Practice autorotation: An autorotation performed per the flight manual training supplement procedure in which the collective is reduced as or just before power is reduced to 67% NG. Please see the attached AS350B2 Flight Manual Autorotation training supplement.

- Forced landing autorotation: An autorotation conducted following an unexpected loss of engine power or other emergency event requiring the pilot to shut down the engine in flight. Please see attached Flight Manual Emergency procedure.

Flight Demonstrations:

Members of the investigation team were divided into four groups for aircraft demonstrations, which were conducted in an AEC-owned AS350B3 helicopter due to the lack of availability of an AS350B2. The autorotation characteristics of both variants are the same. The practice autorotation procedure is similar except the AS350B3 is equipped with a twist grip throttle unlike the AS350B2, which is equipped with a floor-mounted fuel flow control lever. An AEC instructor pilot sat in the left front seat, and a pilot from each of the four investigation sub-groups had the opportunity to perform the following maneuvers:

1. Practice autorotation with no power reduction to 67% NG; initiated at ~1200 feet AGL and 80 knots; recovery at bottom (no touchdown) – this maneuver is not in accordance with the Flight Manual training supplement
2. Practice autorotation with power reduction to 67% NG; initiated at ~1200 feet AGL and 80 knots; touchdown – in accordance with the Flight Manual training supplement
3. Practice autorotation with power reduction; initiated at ~1200 feet AGL and 120 knots; touchdown – in accordance with the Flight Manual training supplement

Simulator Demonstrations:

The simulator used for the simulator demonstrations was an Indra full-motion AS350 Simulator, certified to FAA Level B standards. Members of the investigation team were divided into four groups for simulator demonstrations (not the same groups as for aircraft flights). Again, an AEC instructor pilot sat in the left front seat, and a pilot from each of the four investigation sub-groups sat in the right front (pilot) seat. Each person seated in the right front seat had the opportunity to conduct the following maneuvers:

1. Practice autorotation with no power reduction; initiated at ~1200 feet AGL and 80 knots; recovery at bottom (no touchdown) – this maneuver is not in accordance with the Flight Manual training supplement
2. Practice autorotation with power reduction (67% NG); initiated at ~1200 feet AGL and 80 knots; touchdown – in accordance with the Flight Manual training supplement
3. Forced landing autorotation(s) following an unannounced loss of power at a 275 feet AGL and 115 knots (similar altitude and airspeed that was likely experienced during the accident sequence)

Findings:

1. The failure to reduce collective pitch in a timely manner resulted in unrecoverable low rotor RPM.

2. A coordinated combination of reduction of collective pitch and aft cyclic were required to maintain rotor RPM and execute a successful autorotation.

3. When an unannounced loss of power at was initiated at ~275 AGL and ~115 knots:
    a. A proper response (down collective/aft cyclic) resulted in an average time of about 25 seconds between the unannounced loss of power and touchdown.
    b. An improper response (failure to reduce collective pitch or pull cyclic aft) resulted in an average time of four to five seconds between the unannounced loss of power and impact with terrain.