NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
West Chicago, IL 60103

October 15, 2012

OPERATIONS FACTUAL REPORT

CEN11FA599

- *Contains Seven Imbedded Photos* -

A. ACCIDENT

Accident Number: CEN11FA599
Operator: Air Methods Corporation DBA LifeNet
Location: Mosby, Missouri
Date: August 26, 2011
Time: 1841 cdt
Airplane: Eurocopter AS350 B2, N352LN

B. OPERATIONS GROUP

Group not formed.

Jim Silliman
Senior Air Safety Investigator
National Transportation Safety Board
North Central Regional Office
West Chicago, Illinois 60185

C. SUMMARY

On August 26, 2011, at 1841 central daylight time[1], a Eurocopter AS350 B2 helicopter, N352LN, sustained substantial damage when it impacted terrain during an autorotation following a loss of power near the Midwest National Air Center (GPH), 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 GPH to refuel. After refueling, the pilot planned to proceed to Liberty Hospital in Liberty, Missouri, which was located about 7 nm from GPH on a 235 degree heading.[2] Visual meteorological conditions prevailed at the time of the accident, and a company visual flight rules (VFR) flight plan was filed.

D. HISTORY OF FLIGHT

1. Background

Air Methods conducted night vision goggle (NVG) training at the St. Joseph base located at the Rosecrans Memorial Airport (STJ), in St. Joseph, Missouri, during the week before the accident flight. Maintenance records indicate that on August 22nd, the helicopter interior of 352LN was reconfigured in order for the aircraft to be used for NVG pilot training. The medical interior was removed and the copilot's seat, cyclic, collective, and pedals were installed. The aircraft lighting system was NVG compatible and did not require any modification. The accident helicopter was used for NVG training from Tuesday night on August 23rd through

[1] All times in this report are expressed in terms of a 24-hour clock and central daylight time, unless otherwise noted. Actual time of the accident is approximate.
[2] The original flight plan had 352LN flying directly to Liberty Hospital, but the unexpected refueling requirement resulted in a revised flight plan.

early Friday morning on August 26th. On August 26th, the helicopter mechanic based at St. Joseph removed the copilot's seat, cyclic, collective, and pedals from 352LN, and reinstalled the EMS interior. The helicopter was reconfigured for EMS flights and was put back into service about 1530. While 352LN was out of service for NVG training, a "spare" Air Methods AS350 B2, 101LN, was used by the St. Joseph base for EMS flights.

The last NVG training flight in 352LN was completed around 0300 on Friday morning on August 26th. The Air Methods NVG instructor pilot who was providing the NVG training did not have the helicopter refueled after the last flight, because the amount of fuel required for the next EMS mission needed to be determined by the EMS duty pilot. The EMS duty pilot would have been required to base the fuel assessment on weight and balance considerations, such as the weight of the pilot and medical crewmembers. The instructor pilot reported that the fuel gauge indicated there was about 24% of fuel remaining after the NVG training flight. Fuel records obtained from the airport manager showed that 352LN was not refueled on August 26th after it returned from the last NVG flight.

The accident pilot arrived for duty on the day of the accident flight prior to 0630. He received a briefing from the departing night shift pilot that covered the following items: the status of the active helicopter (101LN); the training that had been accomplished using the accident helicopter, and that it needed to be reconfigured for medical work when the mechanic arrived; and that the accident helicopter was low on fuel and needed to be refueled before it went into service. The pilot conducted a preflight of 101LN and signed its Daily Flight Log, because 352LN was still out of service until it was reconfigured for EMS flights.

The helicopter mechanic completed the maintenance logbook entries required to return the helicopter 352LN to service. Two "Conform Your Aircraft (CYA)[3]" entries were made by the helicopter mechanic in the Aircraft Record of Maintenance, log leaf # 718972 on August 26, 2011, but the pilot did not initial the CYA entries as required by the Air Methods General Operations Manual (GOM) before flight. The pilot also did not sign the Daily Flight Log/load manifest for 352LN after the helicopter was put back into service about 1530. The Air Methods GOM, page C-2, states that "The pilot shall record the preflight/airworthiness check by signing the appropriate section of the Daily Flight Log." The pilot and medical crew transferred the pilot and medical gear from 101LN to 352LN once it was back in service on Friday afternoon.[4]

According to the St. Joseph base lead pilot, the duty helicopter is typically loaded with a 70% fuel load each day. A 70% fuel load provides about 2 hours of fuel. When the helicopter needs refueling during normal airport hours, the airport services the helicopter with the fuel truck. At night, the on-duty EMS pilot will refuel the helicopter using the fuel truck.

2. Accident Flight

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 Air Methods' EMS communication center (AirCom) at 1719, and the pilot was notified at 1720. During the initial notification, the pilot accepted the flight and the EMS

[3] Air Methods GOM, page B-28/R-5/01-15-11 states that for all routine maintenance performed in the field by a company mechanic, a CYA check will be performed. If a second mechanic is unavailable to perform the check, a pilot may perform the check, and will initial the CYA entry in the Record of Maintenance. This is consistent with normal operations at the St. Joseph base.

[4] Additional information about the pilot's activities during the day of the accident can be found in the NTSB Human Performance Report.

crewmembers prepared to depart. The helicopter became airborne about 1728. About 1730, the pilot reported to the AirCom communications specialist that 352LN departed STJ with 2 hours of fuel and three persons onboard with a risk code "Blue" (B-Caution). Approximately 28 minutes later the helicopter landed at the Harrison County Community Hospital helipad to pick up the patient.

Once the helicopter was shut down on the hospital helipad, the flight nurse and flight paramedic took their stretcher to the hospital's emergency room to prepare the patient for flight. The pilot stayed in the helicopter and at 1758, contacted the AirCom communication specialist by telephone and notified him that they had landed at the hospital. He also reported that about half way through the flight from STJ, he realized that he did not have as much fuel onboard the helicopter as he originally thought. He stated that he had reported the fuel from 101LN, and not from 352LN. The pilot and communication specialist discussed refueling options since Liberty Hospital was 62 nautical miles (nm) away and would take about 34 minutes en route. Both checked for availability of Jet-A fuel at nearby airports, but the closest airports that had Jet-A were STJ, which was 51 nm away, or at GPH in Mosby, Missouri, which was 58 nm away. At one point, the pilot stated concerning the flight to GPH, "It looks like it's going to be about 27 minutes to me, I think." After the communication specialist informed the pilot that it was 58 nm to GPH, the pilot stated, "Fifty-eight nautical miles. So it would save me, save me 4 nautical miles and 2 minutes. I think that's probably where I'm going to end up going."

The communication specialist asked the pilot if he was going to depart for GPH for fuel and then return for the patient pick-up, or if the pilot intended to refuel with the patient on board. The pilot informed the dispatcher that he would refuel with the patient on board at GPH.

The pilot stated, "I don't want to run short and I don't want to run into that 20-minute reserve[5] if I don't have to…' and, "We'll take off. I'll see how much gas I have when I got and I'll call you when we're in the air."

AirCom transcripts reveal that while the communication specialist and pilot were checking for possible fuel alternatives for 352LN, the communication specialist also had to respond to three calls from two other Air Methods EMS helicopters concerning medical coordination information.[6] The communication specialist changed the flight plan for 352LN in the computer to indicate that the route of flight was now from the hospital in Bethany, Missouri, to GPH instead of Liberty Hospital. Furthermore, the conversation between the accident pilot and the communication specialist was initiated before the completion of the communication specialist's scheduled 12-hour work day, with the shift change time normally occurring at 1800. Neither the pilot nor the communication specialist discussed contacting the Air Methods Operations Control Center (OCC) to inform the OCC of the fuel situation or the changed route of flight.[7]

At 1806, the communication specialist briefed the on-coming communication specialist. He

[5] FAA Part 135 Section 135.209(b): Fuel-planning requirements for VFR operations in helicopters prohibits takeoff in a helicopter under VFR rules unless the helicopter has enough fuel to fly to the airport of first intended landing, and then to fly for 20 minutes of cruising fuel consumption.

[6] The AirCom Communication Specialist was responsible for providing EMS flight following for five Air Methods EMS bases.

[7] The GOM page I-3/R-5/01-15-11 states that the Communications Specialist shall notify the OCC of all overdue aircraft, accident, incidents, damage to aircraft, unscheduled landings, in-flight weather and maintenance aborts. (At the time of the accident, Air Methods did not require the Communication Specialist to notify the OCC concerning 352LN's change of flight plan or fuel status.)

briefed the status of all the EMS helicopters that were currently dispatched, including the fuel situation with 352LN; and the status of all the EMS bases that were handled by their sector. Neither the off-going communication specialist nor the on-coming communication specialist made any mention about whether the OCC should be notified concerning the status of 352LN.[8]

Meanwhile, the medical flight crew arrived back at the helicopter and loaded the patient onto the helicopter's litter. Two hospital emergency room nurses who assisted the medical flight crew reported that neither medical crewmember mentioned anything unusual about the helicopter or about the fuel status of the helicopter.

About 1811, 352LN departed from the Harrison County Community Hospital helipad, and the pilot contacted the AirCom communication specialist and reported that he had 45 minutes of fuel and 4 persons onboard and was en route to GPH. About 1813, the pilot requested that the AirCom communication specialist contact the fixed base operator at GPH to let them know that the helicopter was inbound for fuel. The communication specialist who had just come on duty acknowledged 352LN's radio transmission, and stated that she would notify GPH that 352LN would be landing for fuel.

About 1815, the communication specialist who went off duty notified the AirCom supervisor that 352LN was low on fuel and would be refueling with the patient on board at GPH. The supervisor directed him to contact the medical base supervisor at St. Joseph, but the communication specialist informed him that the medical base supervisor was on board the helicopter.

About 1821, the communication specialist contacted the fixed base operator and informed him that 352LN was inbound for fuel and would be arriving in about 19 minutes. About 1827, the communication specialist notified 352LN that the fuel had been arranged for at GPH. The pilot acknowledged the call. It was the last transmission from 352LN. About 1841, the helicopter impacted a farm field 1.7 nm miles north-northeast of GPH. There was no post impact fire.

About 1844, the on-duty communication specialist contacted the fixed base operator to determine if the helicopter had landed yet. He informed her that the pilot had called "a few minutes ago and I'm sitting in my truck looking for him, but I haven't seen him yet." The communication specialist tried contacting 352LN by radio but without success. About 1853, the AirCom supervisor notified the Air Methods OCC that 352LN was overdue and was low on fuel.

3. Radar Data Review

The radar track data was obtained from the Federal Aviation Administration's (FAA) Kansas City Terminal Radar Approach Control. The target data showed an aircraft operating on a transponder code of 1200 and with performance characteristics consistent with the accident helicopter traveling south toward the accident site just before the reported time of the occurrence. The 1200 code data also matched automated Global Positioning System (GPS) reports provided to Air Methods dispatchers as part of the company's flight following

[8] The GOM page A-20/R-5/01-15-11 states that the Pilot In Command (PIC) has, "Final authority for the safety of passengers, cargo, and medical personnel, and has operational control for all flights which they initiate.

procedures. Terrain elevation along the last part of the helicopter's track varied from approximately 900 to 1,000 feet above mean sea level (msl). The elevation at GPH is 777 feet msl.

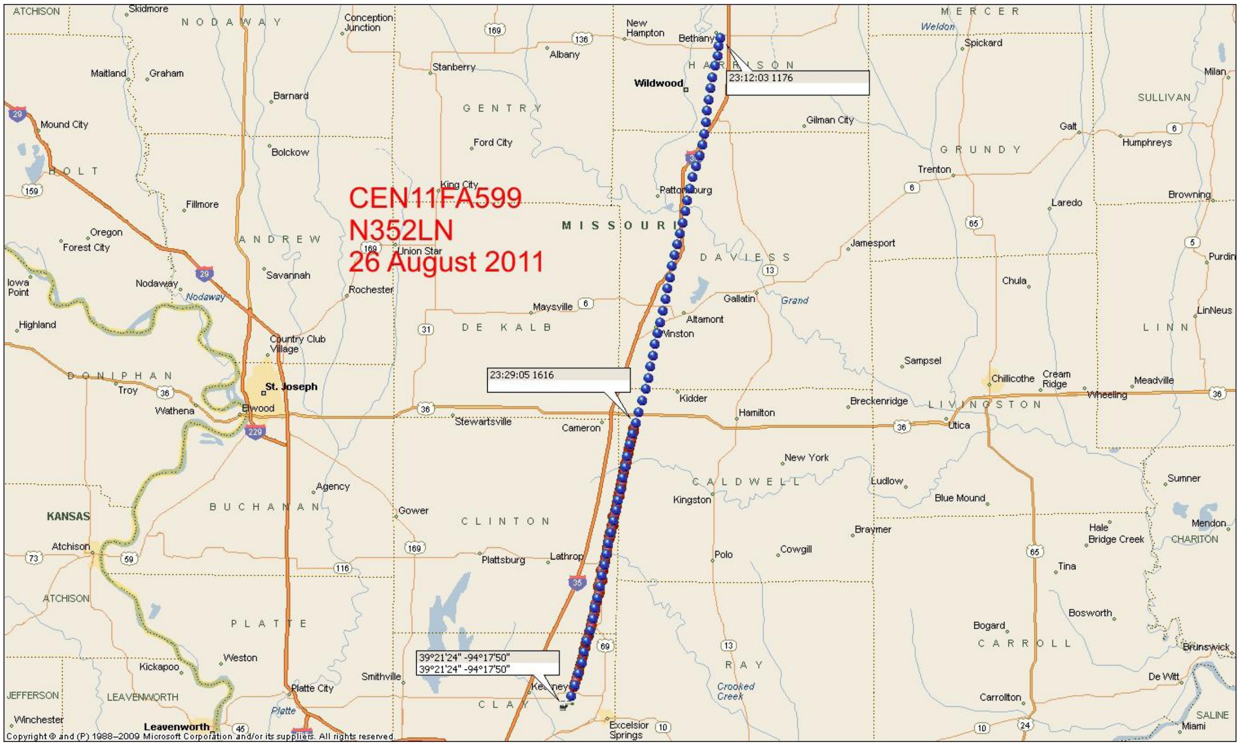

Fig 1 - Overview of flight showing MCI radar data (red dots) and Air Methods tracking data (blue dots.)

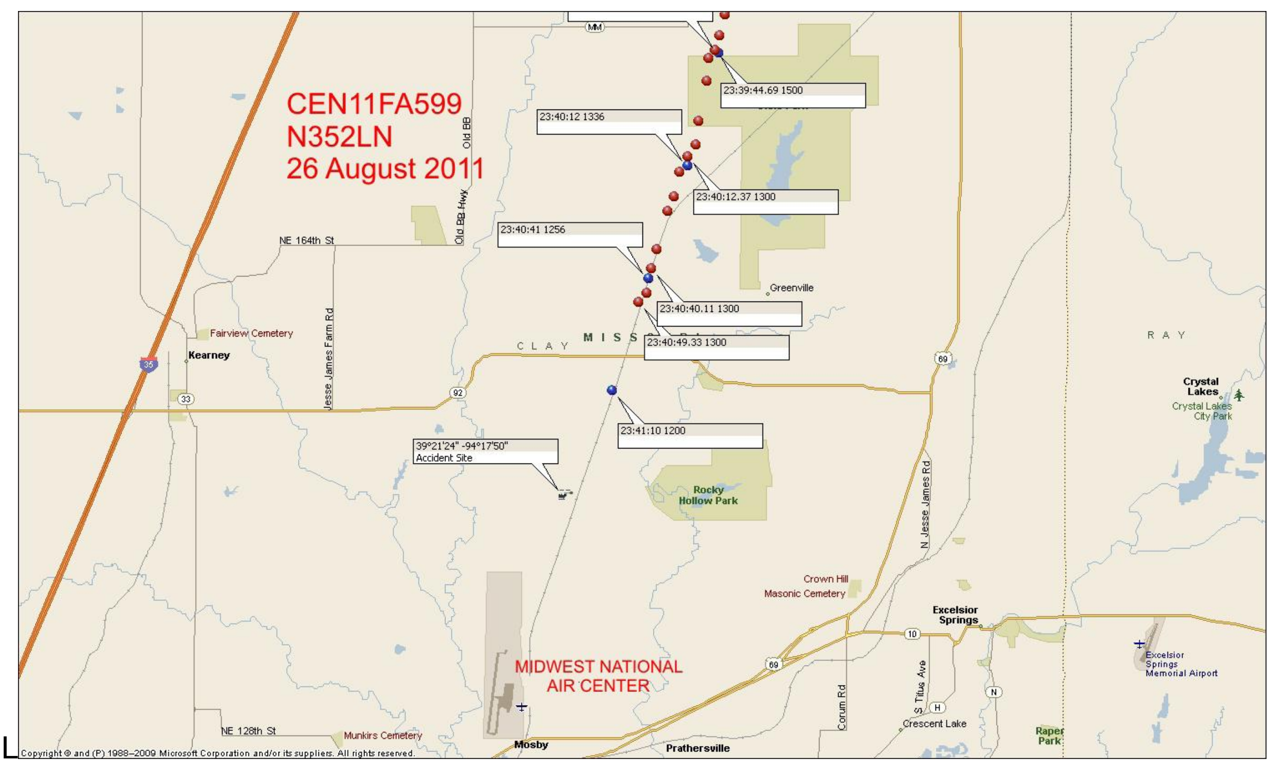

Fig 2 - Last radar targets and GPS position reports along with the location of the destination airport

The combined radar and GPS track data indicated that the helicopter's altitude and airspeed from STJ to the hospital pad at Bethany, Missouri, averaged between 800 to 1,000 feet above ground level (agl) with an average ground speed of about 115 to 120 knots on a 050° heading. After the helicopter departed from the hospital pad en route to GPH, the track data indicated that the helicopter's altitude averaged between 400 to 600 feet agl with an average ground speed of 111 to 116 knots on a 190° heading. At 1841, the last GPS position recorded was about 0.9 nm from the accident site, and it showed the helicopter was about 373 feet agl[9] with a 116 knot ground speed.

4. Aircraft Wreckage Information

The aircraft wreckage was located in a farm field on a direct course line between the Harrison County Community Hospital helipad and GPH. The initial impact point was located about 1 nm from the approach end of runway 18 at GPH (See Wreckage Diagram for additional details).

Photo 1 - Impact in an open field

The aircraft structure was heavily fragmented and scattered along the 100-foot-long debris path, which was oriented on a heading of about 242°. All the impact signatures were consistent with a low rotor 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 40° nose-low and slight left-bank attitude, on a heading of about 030°

[9] AGL Altitude based on GPS Visualizer with a single-point elevation lookup. The trend indicated that the helicopter may have been in a descent.

(nearly opposite to 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° angle, which corresponds to an approximate nose down aircraft attitude of 40°. 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.

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° at the root, and the other two blades were relatively straight. Similarly, the two tail rotor blades exhibited little impact damage and were relatively straight, although one blade was partially separated at the blade root.

Photo 2 - Main helicopter wreckage

The on-site examination of the engine revealed that the axial compressor blades exhibited blade rub opposite the direction of travel. Metal shavings were found in the engine bleed air valve. The Module 5 input pinion nut slippage mark was found intact and not misaligned, which was consistent with an engine rotating but not making power at impact.

The fuel tank assembly was found intact and located in the midst of the main wreckage. No fuel was observed at the accident site. Less than 1 liter of fuel was found in the fuel tank or lines, which were generally intact. The airframe fuel filter system was examined and no fuel was observed in the lines on the engine side of the filter, and only a residual amount of fuel was observed in the lines on the tank side of the filter.

The instrument panel was relatively intact and separated from the airframe; however, most of the instruments could be easily read and observed. Many displayed settings towards the low side of measurements; however, the overall impact damage precluded the ability to rely conclusively on their readings. The instrument panel was configured with NVG lighting and filters. The brightness switch on the caution-warning annunciator panel was found on the low (dim) setting, which would be the correct position for night operations.

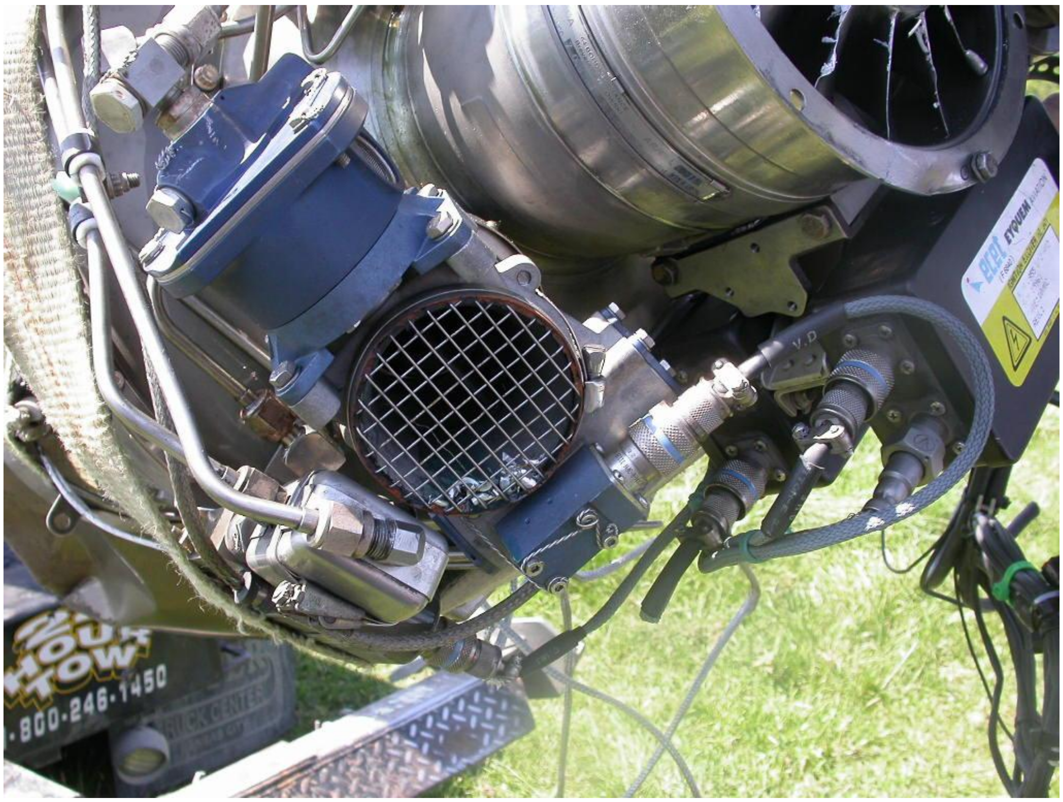

Photo 3 - Metal Shavings in Bleed Air Valve

E. METEOROLOGICAL INFORMATION

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° at 6 knots; 10 miles visibility; clear sky; temperature 31° Celsius; dew point 13° Celsius; altimeter 29.96 inches of mercury.

F. PILOT INFORMATION

The pilot, age 34, held a commercial pilot certificate with rotorcraft-helicopter and instrument-helicopter ratings issued on September 22, 2005. He held a second-class medical certificate with no limitations issued on September 1, 2010. Prior to being employed by Air Methods, the pilot flew for the US Army. In the resume that he presented to Air Methods, the pilot indicated that he had a total of 2,071.1 rotorcraft flight hours of which 895.1 were as pilot in command (PIC) and 200 were in an AH-64-D simulator. He had 1,675.4 multi-engine rotorcraft hours, 200 NVG hours, and 73.1 hours of unaided PIC night hours. He was a PIC in the AH-64-D and he also flew 141.7 hours in the Bell 206-OH-58 A/C. He indicated that he flew 15 hours in a Cessna 172 and Cessna 210, but he did not hold a private pilot's license in single-engine airplanes.

Information provided by Air Methods indicated that the pilot accumulated a total of 104 flight hours in the AS350 B2 and 32 flight hours in the AS350 B3 between October 10, 2010, and August 26, 2011. He flew 18 hours within the 30 days prior to the accident and 74 hours within the 90 days prior to the accident.

Pilot training records showed that the pilot started his Basic Indoctrination Training on September 13, 2010. He started his Initial New Hire Training for the AS350 B, BA, and B2 on October 4, 2011, in 352LN. After receiving 4.2 hours of flight training, he completed the FAR 135.299 Airman Competency/Proficiency Check on October 6, 2010. All areas of the examination were graded as 'S' (satisfactory)[10] and no discrepancies were noted. Instrument procedures were not practiced; however, an ILS approach arrival was performed. Power failures, autorotations to a power recovery (but without a reduction in power), and hovering autorotations (oral only) were performed. He was assigned to the St. Joseph, Missouri, base and completed his base orientation, which included three orientation flights, on October 11, 2010.

On March 7, 2011, the pilot completed NVG Ground training. On March 14 - 16, 2011, he received his initial NVG flight training and recurrent flight training. On March 16, 2011, he received his most recent annual FAR 135.293 Airman Competency/Proficiency Check and his NVG Proficiency Check. All areas of the examination were graded as 'S' and no discrepancies were noted.

On April 12, 2011, the pilot received Differences Training in an AS350 B3. The training was limited to ground training and covered preflight inspections and start procedures. On May 2, 2011, he transferred to Rapid City, South Dakota, where the base helicopter was an AS350 B3.

Pilot Training Flight and Competency/Proficiency Checks [11]

Date	Event	Aircraft Model	Flight Time (hrs)
4 - 6 Oct 10	Initial New Hire Training	AS 350 B2	4 + 08
10 Oct 10	FAR 135.293 check flight	AS 350 B2	1 + 0
11 Oct 10	Local Area Familiarization Training	AS350 B2	2 + 05
14 – 16 Mar 11	Recurrent + NVG training flight	AS 350 B2	4 + 01
16 Mar 11	FAR 135.293 + NVG check flight	AS 350 B2	1 + 01
Total			**12.3**

G. HELICOPTER INFORMATION

The helicopter was a Eurocopter AS350 B2, serial number 3728, and was manufactured in 2003. The FAA Airworthiness certificate was issued on February 6, 2004. FAA registration records show that Air Methods acquired the helicopter on March 30, 2005.

[10] Grading categories: S-satisfactory, U-unsatisfactory, U/S-Retrained, N/A-Not Applicable.
[11] Obtained from Air Methods training records.

The Eurocopter AS350 B2 is powered by a single Arriel 1D1 free turbine engine. The helicopter is equipped with a three blade main rotor system which rotates clockwise (when looking from above), a conventional tail rotor, and skid type landing gear.

It was equipped with an Air Methods EMS Interior and configured for medical transport of a single patient on a litter. The litter was located on the left side of the helicopter which extended from the left side of the cockpit into the left side of the cabin. A review of the helicopter's maintenance records revealed that it had 3,655 total hours at the time of the accident, and the most recent maintenance inspection performed was part of the Air Methods Approved Aircraft Inspection Program on August 26, 2011.

Photo 4 - N352LN Prior to accident

1. Weight and Balance Information

The helicopter's flight manual lists the maximum gross weight as 4,961 pounds with the center of gravity limitations between 125.1 to 135.8 inches. The operational empty weight that was listed in the 352LN's weight and balance records was 3,326.7 pounds with a longitudinal arm of 137.2 inches.

The actual weight and balance calculation performed by the pilot for the accident flight was not recorded at the home base, and was not recovered from the wreckage. Typically, weight and balance calculations were done by the pilot utilizing a spreadsheet program that is available at each base, and tailored for each specific helicopter.

The spreadsheet program used by the pilot to perform weight and balance calculations listed the helicopter weight as 3,326.7 pounds, pilot weight as 261 pounds, medical crew positions as 174 pounds and 226 pounds respectively, and medical equipment as 209 pounds. The total helicopter weight, including the patient (102 pounds), but without fuel was 4,195.2 pounds with a center of gravity at 129.1 inches, which was within the center of gravity limits. (This was approximately the weight and balance condition of the 352LN at the time of the accident.)

Based on the reported crew weights, equipment loading, and reverse fuel calculations from the accident site, 352LN weighed about 4,541 pounds with about a 36% (345 lbs.) fuel load when it departed St. Joseph, Missouri. The helicopter's center of gravity was about 129.1 inches, which was within the center of gravity limits.

2. Fuel State

In order for the pilot to complete the Weight and Balance calculations, the fuel quantity needed to be checked during the preflight. The fuel quantity indication is available as soon as the battery is turned on. The fuel quantity gauge indicates the amount (%) of fuel that is on board.

A fuel chart at the Air Methods' St. Joseph base indicated that the fuel burn rate "rule of thumb" for 352LN was 35% per hour at 105 knots airspeed, which equated to about 50 gallons/hour. Using the rule of thumb burn rate, the flight from STJ to the Harrison County Community Hospital in Bethany, Missouri, which was about 51 nm, would consume about 24 gallons (17% or about 29 minutes) of fuel. The flight from the Harrison County Community Hospital in Bethany, Missouri, to the accident site was about 56 nm, and would consume about 27 gallons (19% or about 33 minutes) of fuel. Not accounting for fuel consumed during aircraft start sequences, 352LN had about 51 gallons (36% or about 62 minutes) of fuel when it departed the base at STJ.

The AS350 B2 Aircraft Flight Manual (AFM) Section 3 states that when the amber "FUEL" light illuminates on the Warning - Caution Advisory Panel, the fuel quantity is less than 15.8 US gallons. It instructs the pilot to avoid large attitude changes. The NOTE states, "Remaining usable fuel allows approximately 18 minutes level flight at maximum continuous power." 15.8 gallons of fuel would indicate approximately 11% on the fuel quantity gauge.

3. Engine Flame-Out: Audio Warnings, Indications, & Pilot Emergency Procedure

Section 3 of the AS350 B2 Flight Manual provides information regarding helicopter emergencies, the warnings or alerts associated with a particular emergency, and the procedures to follow once the emergency has been identified.

The main rotor normal rpm (NR) operating range is from 375 to 394 rpm and is represented by the green arc on the dual gauge rotor and free turbine tachometer on the pilot's instrument panel. Continuous tone audio warnings are provided when NR is below 360 rpm or when hydraulic pressure drops below 30 bars. An intermittent tone is provided when NR is above 410 rpm.

The above-mentioned tones are only operative if the "HORN" button is pushed in per the normal procedures. When this push-button is out, at nominal rotor speed, the HORN light of the warning-caution-advisory panel illuminates to alert the pilot that the HORN is muted.

Section 3.1 of the flight manual contains the following information about the symptoms of a flame-out in flight, as well as the emergency autorotation landing procedure to apply in the event following an engine failure (flame-out).

The symptoms listed for an engine failure (flame-out) are as follows:

- Jerk in the yaw axis (only in high power flight)
- Drop in rotor speed (aural warning sounds below 360 rpm as described above)
- Torque at zero
- Ng falling off to zero
- Generator warning light illuminates
- Engine oil pressure drop warning light illuminates

In the event of an engine failure (flame-out) in flight, carry out autorotation procedure as listed below:

1. Set low collective pitch.
2. Monitor and control rotor rpm.
3. Establish approximately 65 kt (120 km/hr – 75 mph) airspeed.
4. Move the fuel flow control lever to the shutdown position.
5. According to the cause of the loss of the engine:
    - Relight the engine [dependent on altitude]
    - Otherwise: close the fuel shut-off cock, and shutoff generator, alternator if installed, electrical power master switch (if smell of burning).
    - Maneuver to head the helicopter into the wind in final approach.
    - At a height of approximately 65 ft (20 m) above the ground, flare to a nose-up attitude.
6. At height 20-25 ft (6-8 m) and at constant attitude, gradually apply collective pitch to reduce the sink-rate.
7. Resume level attitude before touch-down, and cancel any side-slip tendency.
8. Gently reduce collective pitch after touchdown.

2. Autorotation Information

The FAA Helicopter Flying Handbook (FAA-S-8083-21A)[12] states the following regarding autorotations:

> In a helicopter, an autorotative descent is a power-off maneuver in which the engine is disengaged from the main rotor system and the rotor blades are driven solely by the upward flow of air through the rotor. In other words, the engine is no longer supplying power to the main rotor.
>
> The most common reason for an autorotation is failure of the engine or drive line, but autorotation may also be performed in the event of a complete tail rotor failure, since there is virtually no torque produced in an autorotation. In both areas, maintenance has often been a

[12] FAA Helicopter Flying Handbook (FAA-S-8083-21A), United States Department of Transportation, Federal Aviation Administration, Airman Testing Standards Branch, AFS-630, Oklahoma City, OK, page 11-1

contributing factor to the failure. Engine failures are also caused by fuel contamination or exhaustion as well resulting in a forced autorotation.

Photo 5 – Instrument panel. The red arrow points to the NR gauge.

If the engine fails, the freewheeling unit automatically disengages the engine from the main rotor allowing the main rotor to rotate freely. Essentially, the freewheeling unit disengages anytime the engine revolutions per minute (rpm) are less than the rotor rpm.

At the instant of engine failure, the main rotor blades are producing lift and thrust from their angle of attack (AOA) and velocity. By lowering the collective pitch, which must be done immediately in case of an engine failure, lift and drag are reduced, and the helicopter begins an immediate descent, thus producing an upward flow of air through the rotor system.

Regarding technique of the autorotation, the handbook states that "After entering an autorotation, collective pitch must be adjusted to maintain the desired rotor rpm. Coordinate the collective movement with proper antitorque pedal for trim, and apply cyclic control to maintain proper attitude." Furthermore, the pilot must "adjust attitude with cyclic control to obtain the manufacturer's recommended autorotation or best gliding speed."

U.S. Army Field Manual 1-51, *Rotary Wing Flight*,[13] states that "Autorotations may be

[13] *Rotary Wing Flight*, An edited reprint of selected portions of the U.S. Army Field Manual 1-51, Reprinted by Aviation Supplies & Academics, Inc., Renton, Washington, page 2-72.

divided into three distinct phases: the entry, the steady state descent, and the deceleration and touchdown." Regarding the entry phase, the manual states:

> Entry into autorotation is performed following loss of engine power. Immediate indications of power loss are rotor RPM decay and an out-of-trim condition. Rate of RPM decay is most rapid when the helicopter is at high gross weight, high forward speed, or in high density altitude conditions. All of these conditions demand increased collective pitch and torque to maintain powered flight and so result in rapid RPM decay when the engine stops. In most helicopters, it takes only seconds for the RPM decay to reach a minimum safe range. Pilots must react quickly and initiate a reduction in collective pitch that will prevent excessive RPM decay. A cyclic flare will help prevent excessive decay if the failure occurs at high speed. This technique varies with the model helicopter. Pilots should consult and follow the appropriate aircraft Operator's Manual.

Helicopter Aerodynamics for Naval Aviators[14] notes that that the variables influencing the entry phase of an autorotation are rotor blade pitch, rotor inertia, pilot reaction time, entry altitude and entry airspeed. The text also notes that descents during autorotations are influenced by 5 variables; airspeed, trim, gross weight, up gusts, & rotor RPM (Nr). Gross weight determines rotor RPM at a given collective pitch. At high gross weight, more blade pitch required at a desired RPM. There are tradeoffs for maintaining a high Nr RPM or a low Nr RPM during descent.

Effects of high Nr (rotor RPM):

- Excessive centrifugal loads on the hub
- Excessive propeller region resulting in a higher rate of descent
- Rotational energy to tradeoff in a flare
- Good for high inertia systems which would have difficulty building RPM rapidly in a flare

Effects of low Nr (rotor RPM):

- Higher angle of attack (AOA) therefore a slower rate of descent
- Excessive stall region if RPM gets too low resulting in an increase in rate of descent, less rotational energy to trade off in a flare
- Good for low inertia systems which can build RPM rapidly in a flare
- Rotor blades lose centrifugal stiffness and bend upwards which reduces the effective disk area and increases material stresses
- Blades lose centrifugal force and cone which then reduces the effective disk area and increases the rate of descent.

[14] *Helicopter Aerodynamics for Naval Aviators*, Aviation Safety Programs, Naval Postgraduate School, Monterey, California, pages 207, 223, and 225.

H. PERSONS INTERVIEWED

The operations investigation began at the conclusion of the on scene investigation. Records, manuals, and other pertinent data were obtained from the operator and the Federal Aviation Administration (FAA). Interviews, in person and by telephone, were conducted by the investigator-in-charge (IIC) in conjunction with the NTSB Human Performance Specialist, Dr. Malcolm Brenner.[15]

Personnel interviewed were:

1. Mr. Jay Watson, Certificate Compliance Evaluator, Air Methods
2. Mr. Kevin Coulter, Helicopter Mechanic at St. Joseph, MO, Air Methods
3. Mr. Mike Rudder, Flight Paramedic, Air Methods
4. Mr. Chris Filley, Flight Nurse, Air Methods
5. Wife of Accident Pilot
6. Mr. Gary White, Pilot, Air Methods
7. Mr. Bret Koski, Lead Pilot at St. Joseph, MO, Air Methods
8. Mr. Randy Vandenhul, Area Aviation Manager, Air Methods
9. Mr. Korey Cox, AirCom Communication Specialist, Air Methods
10. Ms. Justine Skyler, AirCom Communication Specialist, Air Methods
11. Mr. Lowell Ferguson, AirCom Shift Manager, Air Methods
12. Ms. Lora Girsch, Nurse, Hamilton County Community Hospital
13. Ms. Christian Carter, Nurse, Hamilton County Community Hospital
14. Mr. Brian Thomas, Pilot, Pilot Union Representative, Air Methods
15. Mr. Peter Palayic, Pilot, Air Methods
16. Mr. Dennis McCall, Chief Pilot, Air Methods
17. Mr. Chris Bassett, Director of Operations, Air Methods
18. Mr. Ed Stockhausen, Director of Safety, Air Methods
19. Mr. Jon Prater, FAA CMT POI for Air Methods

I. COMPANY HISTORY AND OPERATIONS

Air Methods is a commercial on-demand air taxi operator specializing in helicopter emergency medical services (HEMS). The company was established in 1980 in Colorado, and currently serves 48 states with nearly 4,000 employees. Air Methods received its Title 14 Code of Federal Regulations (CFR) Part 135 Operating Certificate, number QMLA253U, on March 1, 1992. Air Methods acquired LifeNet as part of its acquisition of Rocky Mountain Holdings, in 2002. Air Methods is the largest provider of air medical emergency transport services throughout the United States, and provides air medical emergency transport services under two separate operating models, the community-based model and the hospital-based model. The organization operates 404 helicopters and 20 airplanes out of 310 bases. In 2011, Air Methods flew 123,691 air medical flight hours, and conducted 90,695 patient transports.

The company participates in the FAA's voluntary Safety Management System pilot program and has demonstrated progression through the program since 2008. They currently have exited Level 2 and anticipate exiting Level 3 during the first quarter of 2013. Air Methods has experienced steady expansion and acquired the following helicopter emergency medical

[15] NTSB investigator Maryam Allahyar, PH.D., also participated in some of the investigative activities.

service (HEMS) operations over the last 15 years: Mercy Air Service (1997), ARCH (2000), Rocky Mountain Holdings (2002), CJ Systems (2007), and Omniflight (2011). An organizational chart of the company is shown in Figure 3. Solid lines depict a formal and direct relationship between positions. Dashed lines indicate an advisory or indirect relationship, not dual responsibility or job sharing, where communication between the positions is expected.

Air Methods operates in accordance with FAA approved Operations Specifications (Ops Spec) for Title 14 CFR Part 135 under certificate number QMLA253U. The latest Ops Spec un-numbered revision was dated July 18, 2011. Contained in the Ops Spec was authorization to conduct on-demand operations, single engine instrument flight rules passenger-carrying operations, use of an autopilot in lieu of a second-in-command, and night vision goggle operations.

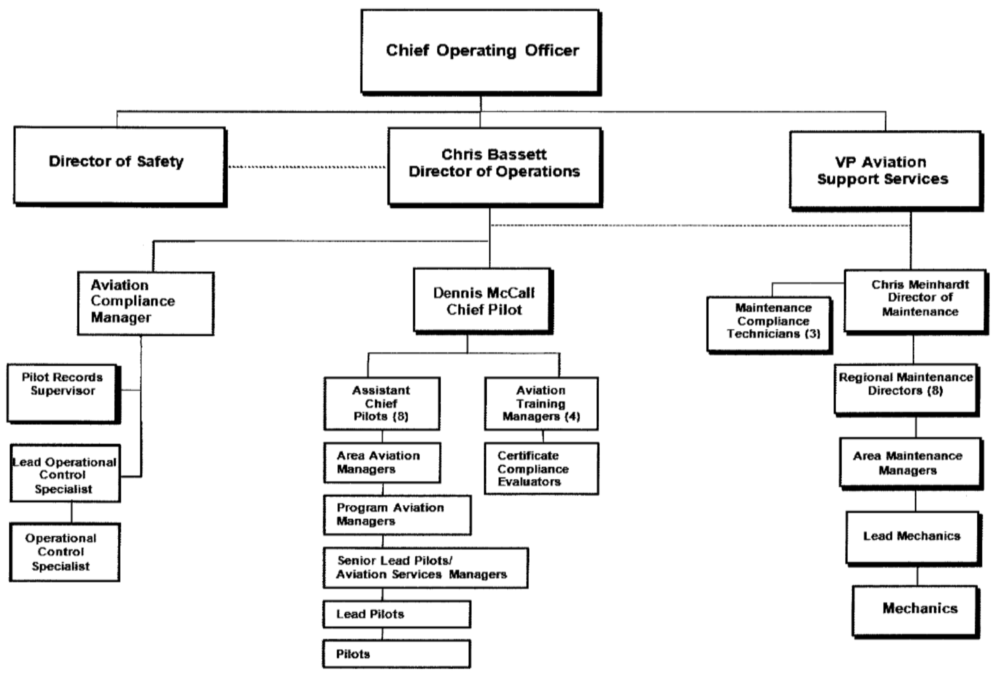

Fig 3 - Air Methods organizational chart.

1.1 General Operating Manual (GOM)

In accordance with 14 CFR Part 135.21, Air Methods kept current a General Operating Manual (GOM), which identified management policies and responsibilities, training/currency policies, and the procedures under which flights are to be conducted. Prior to the accident, the latest revision of the GOM was revision 6, dated August 10, 2011.

1.2 Accident Helicopter's Area of Operations

The accident helicopter and crew were based at the Rosecrans Memorial Airport (STJ), St. Joseph, Missouri. It operates as a community-based model, where EMS helicopters and their crews are provided flight requests through a central communications center (AirCom) in Omaha, Nebraska. The AirCom communication specialist receives the request for services from the local/state run area dispatch system, notifies the pilot of the services request, enters the flight plan, receives the aircraft's 'off call', coordinates the patient transfer with the requesting agency and receiving hospital, and provides flight following.

When AirCom enters the flight plan into the system, the Air Methods Operational Control Center (OCC) in Englewood, Colorado, is notified. The OCC performs flight monitoring and ongoing risk assessment, and a computer system monitors the aircraft position. The OCC can issue a weather warning if the aircraft is within 30 nm of potentially serious weather conditions. A communications system referred to as Skyconnect provides satellite communication via satellite phones that are built into the aircraft's communications suite.

Photo 6 - AirCom Communication Specialist Workstation

1.3 Area Aviation Manager

The Area Aviation Manager has an aviation background and reports to the Assistant Chief Pilot and is responsible for a wide range of activities at the bases in the operating area, including monitoring crew scheduling, pilot training and currency, compliance with Federal Aviation Regulations (FAR's) and safety issues, and oversight of the daily operational activities of the aviation staff. The Area Aviation Manager for the St. Joseph base supervises 14 bases and has held this position for about 2 1/2 years.

According to the Area Aviation Manager, when AirCom contacts the pilot, the pilot has the authority to accept or decline the flight request. There are no penalties associated with declining a flight request or the base being out of service. He stated that Air Methods actively encourages pilots to turn down flight requests if the flight cannot be done safely.

The Base Lead Pilot reports directly to the Area Aviation Manager and is responsible for monitoring pilot currency requirements, correcting safety issues, and pilot scheduling for the three other base pilots. The Base Lead Pilot at St. Joseph was hired by Air Methods in December 2009 and has been in the position since January 2011.

1.4 Pilot Scheduling

The pilots belong to a pilot's union and schedules of service is covered by Article 16 of the collective bargaining agreement (CBA). The CBA states that the pilots at each base shall determine the appropriate schedules of service consistent with company and customer service requirements, and maintain schedules of service, which provide 1 day off for each day scheduled. The St. Joseph base pilots were scheduled in a 7 days on, 7 days off duty cycle. Each 7-day duty period consisted of 4 day shifts and 3 night shifts, or vice versa, to balance the total time between day and night shifts. The typical day shift was from 0630 to 1830, and the typical night shift was from 1830 to 0630. Most pilots arrive about 20 minutes prior to the scheduled turnover time. The St. Joseph base had a double wide trailer home with private rooms where the aircrews can relax and rest to include periods of sleep between flights.

1.5 Operational Risk Assessment Program

Air Methods has developed and implemented an operational risk assessment program to assist pilots in identifying, assessing, and managing risks, and provides mitigation guidance. The risk assessment matrix is utilized for each flight assignment, and is recorded in the daily flight log. The matrix breaks down the categories of risk as green (A-normal operation), blue (B-caution), yellow (C-extreme caution), and orange (D-critical decision to be made). The pilot uses weather criteria and cross references with aircraft status, environment specifics, and fatigue, for both day and night operations. During the accident flight, the pilot reported to AirCom a risk assessment value of “B”. According to Air Methods, a risk assessment value of “B” is common.

1.6 Air Methods Operational Control Center

The Air Methods OCC is primarily responsible for flight monitoring while providing advisory/alert information affecting Air Methods aircraft. Advisories/alerts may include, but are not limited to, flying in the vicinity of marginal or deteriorating weather conditions, temporary flight restrictions (TFR), ground proximity, or any other significant possibility that could become a hazard to flight. All alerts are communicated to the pilot or the appropriate communications center responsible for flight following. The OCC communicates to Air Methods aircraft through a hands free satellite communications system (Skyconnect) that is built into the aircrafts' instrument panel or through the aircraft radios. The OCC is also responsible for initiating and managing Air Methods post-accident/incident response plan. An experienced EMS helicopter pilot is on duty in one of the two OCC workstations.

Photo 7 - Air Methods OCC

1.7 Air Methods GOM Policy on Minimum Altitudes

Air Methods' GOM page BA-8/R-2/08-01-08 provided policy for minimum altitudes for VFR operations. The policy stated:

> At all times, with the exception of takeoffs and landings, Air Methods' pilots will operate at an altitude allowing, if a power unit fails, an emergency landing without undue hazard to persons or property on the surface. While en route, Air Methods' helicopter pilots will maintain at least the following minimum altitudes:
>
> • DAY: 300 feet AGL.
> • NIGHT: 500 feet AGL
>
> In all cases, aircraft will not be operated so as to pose a danger to persons or property on the surface.

1.8 Air Methods GOM Policy on Fueling Procedures

Air Methods' GOM pages B-17/R-2/08-01-08, B-18/R-5/01-15-11, and B-19/R-4/11-09-09 provided policy for fueling procedures. The GOM provided the following information about **Rapid Refueling with Rotors Turning with Medical Personnel and Patient**:

> It is Air Methods policy that no one should be onboard the aircraft during refueling, with the following exception: on rare occasions it may become necessary while en route to a hospital with a critically ill or injured patient to stop for fuel. In this case refueling with the patient onboard is permitted. The patient

will be prepared for rapid evacuation and attended by a Trained Medical Person. It should be emphasized that the Pilot-in-Command will make every reasonable effort in his flight planning to avoid fueling with a patient onboard. The refueling may be done by FBO refueling personnel. The PIC may brief a medical crewmember on supervising the refueling personnel during rapid refueling at an FBO. Refueling information for a specific aircraft make and model can be found in the appropriate Aircraft Flight Manual and must be adhered to.

- The PIC will conduct an exit briefing before allowing the Trained Medical Personnel to exit the helicopter.

- The Trained Medical Personnel will exit the helicopter and post in a position that will allow them to guard the tail rotor and monitor the pilot.

- The PIC will conduct an exit briefing before exiting the aircraft.

- Engine/rotor RPM shall be set to the lowest appropriate setting, the force trim shall be on (if installed), the **autopilot turned off** (if installed) and the rotor disc level.

- A Trained Medical Person with a fire extinguisher, will remain onboard the aircraft with the patient. The patient will be prepared for rapid evacuation.

- The second Trained Medical Person will position himself/herself, with a fire extinguisher (if available) in a position that will allow monitoring of the refueling operation and the onboard attendant simultaneously, so as to be able to coordinate emergency evacuation / firefighting assistance as necessary.

- Fuel Truck will be placed a minimum of 30 feet beyond the rotor arc.

- If an aircraft fuel apparatus or spilled fuel catches fire, engage all fuel shut-offs, shut down and evacuate the aircraft.

- Notify the Fire Department immediately. If possible and without endangering self or others, fight the fire with all means available.

2. Accident History

A review of the NTSB records associated with the operator identified two previous accidents involving autorotations from cruise flight.

1 On July 1, 1991, in cruise flight, the engine to transmission drive shaft forward coupling of a Bell 412 overheated and failed. The pilot executed an autorotation. During the landing flare, the pilot did not maintain adequate rotor rpm, and the helicopter landed hard. Company maintenance personnel dispatched the helicopter with a known drive shaft coupling grease leak, which they had attempted to stop by using an unapproved silicon sealant. The NTSB determined that the probable cause of the accident was the pilot’s failure to maintain adequate main rotor rpm to touchdown. Contributing to the accident was the

disconnected engine to transmission drive shaft and the inadequate inspection by company maintenance personnel.[16]

2 On July 28, 2010, in cruise flight, the Eurocopter AS 250 B3's engine lost power, and the pilot executed an autorotation to a congested area. The investigation determined that the engine lost power when the fuel inlet union that connected to the fuel injection manifold and provided fuel from the hydro mechanical unit to the combustion section detached from the compressor case. The helicopter's engine had undergone maintenance over several days preceding the accident and the fuel inlet union had been removed and replaced during the maintenance. The NTSB determined that the repair station technician did not properly install the fuel inlet union during reassembly of the engine; the operator's maintenance personnel did not adequately inspect the technician's work; and the pilot who performed the post maintenance check flight did not follow the helicopter manufacturer's procedures. Also causal were the lack of requirements by the Federal Aviation Administration, the operator, and the repair station for an independent inspection of the work performed by the technician. A contributing factor was the inadequate oversight of the repair station by the Federal Aviation Administration, which resulted in the repair station performing recurring maintenance at the operator's facilities without authorization.

J. Federal Aviation Administration Information/Oversight

Oversight of Air Methods Corporation FAR Part 135 operating certificate is accomplished primarily by a certificate management team (CMT) based at the Denver Flight Standards District Office in Denver, Colorado. The CMT staffing at the time of the accident was 27 CMT members. There was one assigned Principal Operations Inspector, one Principal Maintenance Inspector, and one Principal Avionics Inspector who were assisted by 8 operations inspectors, 7 maintenance inspectors, and 3 avionics inspectors. (There was also an additional Principal Maintenance Inspector and Principal Avionics Inspector assigned to provide oversight of the company's FAR Part 145 repair stations.) The CMT is comprised of an Operations and an Airworthiness unit. Each unit has an assigned operations and airworthiness supervisor respectively.

The oversight program development for Air Methods uses a combination of National Work Program Guidelines and the FAA's Large FAR Part 135 Safety Evaluation Program (SEP) and the Safety Evaluation Assessment Tool (SEAT) processes. This process allows the development of a comprehensive work program based on identified risks. Implementation of the program is accomplished by the CMT members, who travel throughout the carrier's system performing inspections and evaluations. Three of the CMT operations members are remotely sited in Virginia, Tennessee, and Massachusetts.

The CMT also utilizes inputs from other offices located throughout the U.S. The CMT does not specifically generate work program items for the other offices; however, it does encourage support from the Flight Standards community. "Local" offices have and do incorporate work in their local geographic work programs. During FY 2010 and FY 2011, there were a total of 6,481 surveillance activities on the carrier. (This included operations,

[16] NTSB accident identification number: DEN91LA095

airworthiness, and avionics.) Of those activities, 1,019 were accomplished by offices other than the Denver Flight Standards District Office.

Review of the FAA's Program Tracking Reporting Subsystem (PTRS) records from 08/26/2008 to 08/26/2011, revealed that the FAA conducted 71 inspections at Air Methods' St. Joseph base. Overall, there were 68 satisfactory and 3 unsatisfactory results. In all three cases, the unsatisfactory conditions were corrected on-the-spot by the operator. During the three year period, there were 29 ramp checks of Air Methods aircraft with 26 satisfactory and 3 unsatisfactory (as noted above). There were 7 checks of Air Methods pilots, all satisfactory and 35 base inspections, all satisfactory. During the 3 year period, 14 of the inspections were carried out by personnel from the Certificate Management Office in Denver, Colorado, and the remainder were carried out by personnel from the Kansas City Flight Standards District Office.

Jim Silliman
NTSB, Central Region