Aviation Investigation Final Report

Location:	Greensburg, Indiana	**Accident Number:**	CHI08FA269
Date & Time:	August 31, 2008, 13:20 Local	**Registration:**	N37AE
Aircraft:	Bell 206L-1	**Aircraft Damage:**	Destroyed
Defining Event:	Sys/Comp malf/fail (non-power)	**Injuries:**	3 Fatal
Flight Conducted Under:	Part 91: General aviation - Positioning		

Analysis

The emergency medical services crew had attended a local fundraising event and was returning to the helicopter/crew base when the accident occurred. Witnesses reported that the helicopter made a normal departure. They subsequently reported seeing components separate from the helicopter before it descended and impacted the ground. The helicopter came to rest in a corn field approximately 1.2 miles from the departure point. A postaccident examination of the helicopter revealed that an 8-foot section of one of the main rotor blades separated in-flight rendering the helicopter uncontrollable. Metallurgical examination determined that the blade failed as a result of fatigue cracking. The origin of the fatigue crack coincided with a large void between the blade spar and an internal lead weight. Further investigation determined that the presence of residual stresses in the spar from the manufacturing process, in combination with excessive voids between the spar and the lead weight, likely resulted in the fatigue failure of the blade. The manufacturer issued an alert service bulletin that identified main rotor blades that may have been affected by the combination of residual stresses and excessive voids between the spar and the lead weight. The service bulletin also called for supplemental inspections in order to maintain the continued airworthiness of the affected blades.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The in-flight separation of a main rotor blade due to a fatigue failure of the blade spar, rendering the helicopter uncontrollable, and the manufacturer's production of main rotor blades with latent manufacturing defects, which precipitated the fatigue failure of the blade spar.

Findings

Aircraft	Main rotor blade system - Failure
Organizational issues	(general) - Manufacturer

Factual Information

History of Flight

Enroute-cruise	Sys/Comp malf/fail (non-power) (Defining event)
Enroute-cruise	Part(s) separation from AC
Enroute-cruise	Loss of control in flight
Uncontrolled descent	Collision with terr/obj (non-CFIT)

HISTORY OF FLIGHT

On August 31, 2008, about 1320 eastern daylight time, a Bell 206L-1 helicopter, N37AE, operated by Air Evac EMS Inc., was destroyed during an in-flight collision with terrain and post impact fire near Greensburg, Indiana. The flight was being conducted under 14 Code of Federal Regulations Part 91 without a flight plan. Visual meteorological conditions prevailed. The pilot, flight nurse, and paramedic sustained fatal injuries. The accident flight departed at 1317 from Burney, Indiana, with the intention of returning to the aircraft's base located in Rushville, Indiana.

The crew had attended a local fund raising event for the Burney fire station in a community support role. No patient transport activity was associated with the flight to the fire station, or with the accident flight. The crew had arrived at the event about 1150 that morning. The return flight lifted off at 1317.

Witnesses reported that the helicopter appeared to depart the fire station without difficulty. One witness recalled seeing the helicopter clear a set of high-tension power lines east of the fire station. Witnesses stated that they subsequently saw components separate from the helicopter before it descended and impacted the ground.

Local authorities from the fire station in Burney responded upon witnessing the accident. One firefighter estimated that they were on-scene within 2 minutes. The helicopter came to rest approximately 1.2 miles north-northeast of the departure point in a cornfield.

PERSONNEL INFORMATION

The accident pilot, age 43, held a Commercial Pilot certificate with rotorcraft helicopter and single-engine land airplane ratings. His certificate also included an instrument rating for both helicopters and airplanes. The airplane rating was limited to private pilot privileges. He was issued a Second-Class Airman medical certificate without limitations or waivers on April 22, 2008.

The accident pilot was hired by the operator on June 14, 2006. His most recent Part 135

checkride was completed on June 10, 2008. The pilot had acquired approximately 5,493 hours total flight time. Of that flight time, about 5,176 hours were in helicopters and 1,915 hours were in the same make and model as the accident aircraft. He had accumulated about 38 hours and 9 hours in the 90-day and 30-day periods prior to the accident, respectively. He had acquired about 419 hours during his tenure with the company.

According to the operator's duty logs, the accident pilot had been scheduled for 12-hour shifts from 0800 until 2000, for a 7-day period beginning on August 25th. The accident occurred on the 7th day of the rotation. He had flown 3.1 hours during that 6-day period, with 1.5 hours flown the previous day. He was off-duty for the 4 days prior to that 7-day assignment.

AIRCRAFT INFORMATION

The accident helicopter, N37AE, was a 1979 Bell Helicopter Textron 206L-1, serial number 45230. It was powered by a Rolls-Royce/Allison Model 250-C30P turbo-shaft engine, serial number CAE-895470. The helicopter was certificated under FAA type certificate H2SW. It was owned and operated by Air Evac EMS Inc in an air medical transport role.

According to the operator's maintenance records, the accident helicopter had accumulated 26,250 hours total flight time as of the day of the accident. The engine had accumulated 11,554 hours, which was comprised of 27,403 start cycles.

The helicopter was maintained under an FAA Approved Aircraft Inspection Program (AAIP). The most recent AAIP phase inspection was completed on August 21, 2008. The inspection consisted of an Event 1 and a 200-Hour procedure as outlined in the AAIP. The airframe time was recorded as 26,243.9 hours, at the time of that inspection. Prior to that, an Event 4 inspection procedure had been accomplished on August 12, 2008, at 26,232.5 hours airframe time.

The records contained a maintenance discrepancy that stated: "While on approach heard (and) felt low rumble (and) vibration from rear of aircraft." The entry was dated August 21, 2008, the same day as the Event 1 and 200-Hour progressive phase inspection. The aircraft time noted was 1.3 hours after the inspection. The resulting maintenance inspection did not reveal any anomalies. A ground run and flight check could not duplicate the write-up, nor did they identify any discrepancies. There was no mention of a similar discrepancy in the maintenance records subsequent to that event.

Maintenance records indicated that the main rotor blades (part number 206-015-001-115, serial numbers A-5165 and A-5168) were installed on the accident helicopter on March 21, 2005. Both blades were new at that time. The aircraft flight time was 23,442 hours at installation. At the time of the accident, the blades had accumulated about 2,808 hours time in service. The blade service life was 3,600 hours.

A review of aircraft discrepancy and maintenance records provided by the operator from

January 1, 2008, through the date of the accident, did not reveal any write-ups related to the main rotor blades.

The accident helicopter was based at Rushville, Indiana, which was located about 18 miles north of the accident site.

METEOROLOGICAL INFORMATION

The closest weather reporting facility to the accident site was Columbus Municipal Airport (BAK), which was located approximately 16 miles west-southwest of the accident site. The airport was equipped with an Automated Weather Observing System (AWOS).

At 1250 the BAK AWOS recorded conditions as: Winds from 090 degrees at 9 knots; 10 miles visibility; clear skies; temperature 30 degrees Celsius; and altimeter 30.18 inches of mercury. The dew point was not available.

At 1350, the BAK AWOS recorded conditions as: Winds from 080 degrees at 10 knots; 10 miles visibility; few clouds at 4,000 feet above ground level; temperature 30 degrees Celsius; and altimeter 30.16 inches of mercury. The dew point was not available.

WRECKAGE AND IMPACT INFORMATION

The accident site was located in a cornfield approximately 1.2 miles north-northeast of the departure point. The main wreckage consisted of the fuselage, engine, tail boom, and landing skids. The fuselage was consumed by a post impact fire. The tail boom and landing skids separated from the fuselage. The tail boom was located about 10 feet south of the fuselage, and the skids were located about 10 feet southwest of the fuselage. The main rotor blade/hub assembly separated at the rotor mast and came to rest approximately 220 yards west-southwest of the main wreckage.

The fuselage came to rest nearly inverted. It was oriented on an approximate 317-degree magnetic heading. The cockpit and cabin areas were destroyed by impact forces and the post impact fire. The flight controls were damaged consistent with impact forces. The engine assembly remained secured to the airframe. The transmission separated from the airframe and was located about 194 yards northeast of the main wreckage. Post accident examinations of the engine and transmission did not reveal any anomalies consistent with a pre impact failure.

The main rotor blades remained attached to the hub. One blade was intact. The other blade was fractured into three sections, with the inboard blade section remaining attached to the hub. The two separated blade sections were recovered at the accident site. The outboard section, about 8 feet in length, was recovered approximately 147 yards west-northwest of the main wreckage. The mid-blade section, about 3 feet in length, was recovered approximately 40 yards west-southwest of the main wreckage. The main rotor hub and attached rotor blades

had separated from the aircraft. The main rotor mast failed near the lower surface of the hub. The mast was bent in the direction of the failed blade immediately above the point of failure. The mast exhibited indentations matching the teetering stops on the hub. The fracture surface of the main rotor mast exhibited 45-degree shear planes and a course, dull appearance consistent with overload failure. The main rotor blade yokes were intact and the pitch change horns appeared undamaged. The mating pitch change link rod ends remained attached to the horns. The torsion-tension strap was intact.

The tail boom separated from the airframe approximately 12 inches aft of the tail boom to fuselage attachment. A linear indentation was observed on the left side of the tail boom forward of the horizontal stabilizer. The left horizontal stabilizer was separated from the tail boom near the root consistent with a main rotor blade strike. It was recovered about 212 yards south of the main wreckage. The right horizontal and vertical fin stabilizers remained attached to the tail boom.

MEDICAL AND PATHOLOGICAL INFORMATION

An autopsy of the pilot was performed by the Marion County Coroner's Office, Indianapolis, Indiana, on September 2, 2008. The cause of death was attributed to multiple blunt force trauma sustained in the accident.

A Forensic Toxicology Fatal Accident Report was prepared by the FAA Civil Aeromedical Institute. The results were negative for all substances tested.

COMPANY INFORMATION

Air Evac EMS, LLC, dba Air Evac Lifeteam, was a commercial on-demand air taxi operator, which was authorized to conduct Part 135 visual flight rules (VFR) day and night operations. The company provided medical air transportation services from a total of 82 bases over 13 states. The company employed approximately 350 pilots and 106 mechanics. The company operated approximately 100 aircraft, including Bell 206 series and Bell 407 helicopters

Air Evac utilized an FAA approved pilot training program that addressed new hire, initial aircraft, recurrent, re-qualification, transition, and upgrade training. Training activity was monitored by the Chief Pilot and Director of Operations in order to insure compliance with company requirements and FAA regulations. The accident pilot had previously completed all required training at the time of the accident.

Air Evac operated an Enhanced Operational Control Center (EOCC) that provided oversight for all company flights. Flight tracking was accomplished with automated global positioning system (GPS) flight following and radio communications. GPS flight following provided the EOCC with automated updates of aircraft position and flight progress. This information was continuously displayed and available to EOCC personnel. The pilot was also required to make routine radio reports during a flight to the EOCC.

Aircraft were maintained in accordance with an FAA approved inspection program. Program compliance was the responsibility of the lead mechanic at each base. Maintenance and inspection program activity was monitored at the corporate level by the Director of Maintenance.

TESTS AND RESEARCH

The National Transportation Safety Board materials laboratory conducted a metallurgical examination of the failed rotor blade. The main rotor blade was a bonded assembly. The main components were an extruded aluminum leading edge spar, with upper and lower aluminum skins, and an aluminum honeycomb core. In addition, a lead weight was bonded to the inside of the leading edge spar.

The failed blade bore a Bell Helicopter Textron identification tag, which denoted part number 206-015-001-115 and serial number A5165. The blade exhibited a complete fracture about 96 inches (8 feet) from the tip, about blade station 126.5. The profile of this fracture was oriented directly across the blade from leading edge to trailing edge. A second section of the blade was fractured approximately 134 inches from the tip, about blade station 88.5. The profile of this fracture was irregular.

Examination of the fracture surfaces common to the 8-foot blade section revealed ratchet marks and fine elliptical clamshell marks typical of fatigue cracking. These marks emanated from the inner face of the spar at the transition radius between the leading edge and the upper wall. The crack propagated upward through the wall of the spar and to both sides of the fatigue origin area. The fatigue had grown to encompass approximately 50-percent of the cross-sectional area of the spar prior to ultimate failure.

The surface of the spar at the fatigue origin exhibited no evidence of corrosion or previous mechanical damage (e.g. gouges, scratches, etc.). The spar did exhibit fine lengthwise extrusion marks.

The origin of the fatigue crack coincided with a large void in the adhesive between the inside surface of the spar and the lead weight. The cross-section of the void at the location of the crack initiation was approximately 0.4 inches by 0.1 inches. The total length of the void extending both inboard and outboard of the crack location was about 9.2 inches. The surface of the spar was clean and showed no evidence of adhesive material being in contact with it at the fracture location.

Further investigation by the manufacturer determined that the presence of residual stresses in the spar from the manufacturing process, in combination with excessive voids between the spar and the lead weight, can lead to a fatigue failure of the blade.

ADDITIONAL INFORMATION

As a result of the accident investigation, the manufacturer released Alert Service Bulletin 206L-09-159 (Revision A). The bulletin informed operators that a combination of residual stresses in the spar and excessive voids between the spar and weight may lead to fatigue cracking in the blade. The bulletin included a listing of main rotor blades that may have been affected by the combination of residual stresses and excessive voids between the spar and weight. For the affected blades, the bulletin recommended a recurring surface cleaning (wipe check) and visual inspection for cracks, or an x-ray inspection in order to identify voids between the spar and the lead weight. In the event that there are no voids exceeding the manufacturing limitations, no further inspection was recommended. However, if excessive voids are identified, the recurring visual inspection was recommended to continue for the life of the blade.

In addition, during the course of the investigation, the manufacturer determined that several main rotor blades had been manufactured with an oversized spar spacer (aft spar closure). In response, the manufacturer issued Alert Service Bulletin 206L-09-163. This bulletin notified operators that the combination of an oversized spar spacer and a larger than acceptable void between the spar and the lead inertia weight between blade stations 100 and 145, may cause fatigue cracking in the spar. For blades verified to have been manufactured with an oversized spar spacer, the bulletin recommended reducing the service life of the blade from 3,600 flight hours to 2,300 flight hours. In addition, for main rotor blades with more than 1,200 flight hours, a recurring surface cleaning (wipe check) and visual inspection for cracks, or an x-ray inspection in order to identify voids between the spar and the lead weight was recommended.

OTHER INFORMATION

The weather conditions that existed at the accident site during the time of the accident were observed to be clear, with 10 miles visibility. Daylight conditions prevailed. The helicopter was equipped with a terrain awareness warning system (TAWS). A radar altimeter was installed on the helicopter. The accident flight was being tracked by a flight following program, and did receive flight dispatch services upon initiation of the flight. Additionally, a formal flight risk assessment was performed prior to the flight.

On February 7, 2006, the NTSB issued four safety recommendations to the FAA addressing EMS operations. They are as follows:

NTSB Recommendation No. A-06-12 - Require all EMS operators to comply with 14 CFR Part 135 operations specifications during the conduct of all flights with medical personnel onboard.

NTSB Recommendation No. A-06-13 - Require all EMS operators to develop and implement flight risk evaluation programs that include training all employees involved in the operation, procedures that support the systematic evaluation of flight risks, and consultation with others trained in EMS flight operations if the risks reach a predefined level.

NTSB Recommendation No. A-06-14 - Require EMS operators to use formalized dispatch and flight-following procedures that include up-to-date weather information and assistance in flight risk assessment decisions.

NTSB Recommendation No. A-06-15 - Require EMS operators to install terrain awareness and warning systems on their aircraft and to provide adequate training to ensure that flight crews are capable of using the systems to safely conduct EMS operations.

These four recommendations were also placed on the NTSB's "Most Wanted List of Safety Improvements" in October 2008.

Additionally, the NTSB stated in its January 2006 Special Investigation Report on EMS Operations that they were pleased that the FAA encouraged the use of night vision imaging systems in EMS operations, and that the NTSB would continue to monitor the applicability and usage of these devices in the EMS industry.

Also, on December 21, 2007, the NTSB issued two safety recommendations to the FAA regarding the use of radar altimeters in EMS night operations. They are as follows:

NTSB Recommendation No. A-07-111 - Require helicopter EMS operators to install radar altimeters in all helicopters used in HEMS night operations.

NTSB Recommendation No. A-07-112 - Ensure that the minimum equipment lists for helicopters used in helicopter EMS operations require that radar altimeters be operable during flights conducted at night.

Pilot Information

Certificate:	Commercial	**Age:**	43,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	
Instrument Rating(s):	Airplane; Helicopter	**Second Pilot Present:**	No
Instructor Rating(s):	None	**Toxicology Performed:**	Yes
Medical Certification:	Class 2 Without waivers/limitations	**Last FAA Medical Exam:**	April 22, 2008
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	June 10, 2008
Flight Time:	5493 hours (Total, all aircraft), 1915 hours (Total, this make and model), 5467 hours (Pilot In Command, all aircraft), 38 hours (Last 90 days, all aircraft), 9 hours (Last 30 days, all aircraft), 1 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Bell	**Registration:**	N37AE
Model/Series:	206L-1	**Aircraft Category:**	Helicopter
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	45230
Landing Gear Type:	Skid	**Seats:**	5
Date/Type of Last Inspection:	August 21, 2008 AAIP	**Certified Max Gross Wt.:**	4150 lbs
Time Since Last Inspection:		**Engines:**	1 Turbo shaft
Airframe Total Time:	26244 Hrs as of last inspection	**Engine Manufacturer:**	Rolls-Royce
ELT:	Installed, activated, did not aid in locating accident	**Engine Model/Series:**	250-C30P
Registered Owner:	Air Evac EMS Inc.	**Rated Power:**	600 Horsepower
Operator:	Air Evac EMS Inc.	**Operating Certificate(s) Held:**	On-demand air taxi (135)
Operator Does Business As:	Air Evac Lifeteam	**Operator Designator Code:**	

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	BAK,656 ft msl	**Distance from Accident Site:**	13 Nautical Miles
Observation Time:	13:50 Local	**Direction from Accident Site:**	255°
Lowest Cloud Condition:	Few / 4000 ft AGL	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	10 knots / None	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	80°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	30.15 inches Hg	**Temperature/Dew Point:**	30°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Burney, IN	**Type of Flight Plan Filed:**	None
Destination:	Rushville, IN	**Type of Clearance:**	None
Departure Time:	13:15 Local	**Type of Airspace:**	

Wreckage and Impact Information

Crew Injuries:	3 Fatal	**Aircraft Damage:**	Destroyed
Passenger Injuries:	N/A	**Aircraft Fire:**	On-ground
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	3 Fatal	**Latitude, Longitude:**	39.332221,-85.620277

Administrative Information

Investigator In Charge (IIC):	Sorensen, Timothy
Additional Participating Persons:	Douglas Tate; FAA-Indianapolis FSDO; Indianapolis, IN Dave Hardin; Air Evac Lifeteam; West Plains, MO Harold Barrentine; Bell Helicopter; Fort Worth, TX Jon-Adam Michael; Rolls-Royce; Indianapolis, IN
Original Publish Date:	June 27, 2011
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=68844

The National Transportation Safety Board (NTSB) is an independent federal agency charged by Congress with investigating every civil aviation accident in the United States and significant events in other modes of transportation—railroad, transit, highway, marine, pipeline, and commercial space. We determine the probable causes of the accidents and events we investigate, and issue safety recommendations aimed at preventing future occurrences. In addition, we conduct transportation safety research studies and offer information and other assistance to family members and survivors for each accident or event we investigate. We also serve as the appellate authority for enforcement actions involving aviation and mariner certificates issued by the Federal Aviation Administration (FAA) and US Coast Guard, and we adjudicate appeals of civil penalty actions taken by the FAA.

The NTSB does not assign fault or blame for an accident or incident; rather, as specified by NTSB regulation, "accident/incident investigations are fact-finding proceedings with no formal issues and no adverse parties … and are not conducted for the purpose of determining the rights or liabilities of any person" (Title 49 *Code of Federal Regulations* section 831.4). Assignment of fault or legal liability is not relevant to the NTSB's statutory mission to improve transportation safety by investigating accidents and incidents and issuing safety recommendations. In addition, statutory language prohibits the admission into evidence or use of any part of an NTSB report related to an accident in a civil action for damages resulting from a matter mentioned in the report (Title 49 *United States Code* section 1154(b)). A factual report that may be admissible under 49 *United States Code* section 1154(b) is available here.