Aviation Investigation Final Report

Location:	St. Paul, Minnesota	**Accident Number:**	CHI00FA111
Date & Time:	April 14, 2000, 16:12 Local	**Registration:**	N225LL
Aircraft:	Bell 222U	**Aircraft Damage:**	Substantial
Defining Event:		**Injuries:**	2 None
Flight Conducted Under:	Part 91: General aviation - Positioning		

Analysis

During cruise flight the pilot lost control of the helicopter and an uncontrolled forced landing was made onto the top of a two-story industrial warehouse. The pylon mounted actuator support assembly had separated from the transmission case. The support assembly, attachment hardware, and portions of the transmission case were sent to the NTSB Materials Laboratory for analysis. According to the NTSB Materials Laboratory Factual Report, "... all of the studs showed progressive fatigue cracking from multiple origins." The report stated, "All but one stud fracture ... showed progression from diametrically opposed sides, typical of reversed bending fatigue loads." The report stated that all of the stud and dowel holes in the actuator support were, "... elongated on opposite sides from contact with the respective dowel or stud." The report further stated, "In addition to the elongation of the holes, the faying surfaces of the support and the transmission case were severely worn from relative movement. The directions of indicated movements and wear correspond to the axis of elongation of the respective support holes." The lead mechanic for the helicopter reported that one of the dowel pins was found during routine maintenance approximately one year prior to the accident date and the maintenance staff did not determine the identify the source of the dowel pin.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The loss of clamp-up force between the transmission case and the pylon mounted actuator support assembly which resulted in fatigue failure of the threaded studs and dowel pins, the failure of the flight control system, helicopter control not being possible after the flight control failure, and the inadequate maintenance procedures by the company maintenance personnel.

Findings

Occurrence #1: LOSS OF CONTROL - IN FLIGHT
Phase of Operation: CRUISE

Findings
1. (C) FLIGHT CONTROL SYSTEM - FAILURE
2. (C) FLIGHT CONTROL SURFACES/ATTACHMENTS - FATIGUE
3. (C) AIRCRAFT CONTROL - NOT POSSIBLE - PILOT IN COMMAND
4. (C) MAINTENANCE,INSPECTION - INADEQUATE - COMPANY MAINTENANCE PERSONNEL

Occurrence #2: IN FLIGHT COLLISION WITH OBJECT
Phase of Operation: DESCENT - UNCONTROLLED

Factual Information

HISTORY OF FLIGHT

On April 14, 2000, at 1612 central daylight time, a Bell 222U helicopter, N225LL, piloted by a commercial pilot, was substantially damaged during an in-flight collision with a warehouse following a loss of control while in cruise flight to the St. Paul Downtown Airport/Holman Field (STP), St. Paul, Minnesota. Visual metrological conditions prevailed at the time of the accident. The positioning flight was being operated under the provisions of 14 CFR Part 91 without a flight plan. The pilot and the flight paramedic reported minor injuries. The flight departed the Abbott-Northwestern Hospital, Minneapolis, Minnesota, approximately seven minutes prior to the accident.

According to the pilot's written statement, the flight was returning from a patient drop-off at the Abbott Northwestern Hospital and was en route to STP. The pilot reported that about halfway back to STP he felt a "tick" in the cyclic control in the aft direction. The pilot stated that he switched off the Flight Control System (FCS) to troubleshoot the occurrence and then turned the system back on. The pilot reported that the servo indicators appeared to be in their normal positions. The pilot stated that as the helicopter neared the Minnesota State Capital Building he felt the "tick" again as he turned for a downwind entry to taxiway bravo at STP. The pilot reported that he was around 800-900 feet above ground level (agl) for noise abatement, when the helicopter pitched-up. The pilot reported the following:

"... severe nose high climb attitude. The cyclic stick harded over to the full aft position. I was unable to move any of the flight controls except the pedals. The aircraft continued over, now upside down and diving towards the ground, still at cruise power. Unable to move the cyclic, the aircraft continued this inside loop type of attitude and started up again. Until this point I believe I was trying to manipulate the flight controls normally with one hand on the collective, and my right on the cyclic. I was not strong enough so I tried moving the cyclic with both hands. As about this the cyclic started moving on it's own, and the fight now was trying to keep the controls centered. The aircraft was completely out of control with me having minimal impact on adjusting the flight controls."

"I either told the paramedic or he on his own initiative lowered the collective using both hands. The aircraft then was diving at the ground and it seemed like I was more able to keep it somewhat in a level attitude. I flared with cyclic to arrest the rate of decent and then we ballooned up in pitch. I was trying to place the aircraft in a parking lot when we did this pitch-up. As we climbed up again I saw power lines to my front with a road beyond that had enough room to set the aircraft down. As I tried to raise the collective to go over these wires, the rotor bled off with the low rotor audio and lights. I realized the aircraft was not going to clear the wires, so I jammed full left pedal and placed the helicopter on the roof of a two-story building

immediately to my left."

PERSONNEL INFORMATION

The pilot held a commercial pilot certificate with helicopter and multiengine land airplane ratings. The pilot also held a private pilot certificate with a single engine land airplane rating. The pilot was instrument rated in helicopters and airplanes. The pilot's last aviation medical examination was on July 13, 1999, and was issued a first class medical with no limitations or waivers.

The pilot was reported to have accumulated a total flight time of 3,406 hours at the time of the accident, of which 359 hours were in the Bell 222U helicopter. The pilot was reported to have flown 87 hours in the 90 days preceding the accident, of which 84 hours were in the Bell 222U. The pilot was reported to have flown 23 hours in the Bell 222U during the last 30 days and 2 hours during the last 24 hours.

The pilot's last flight review, as required by Federal Aviation Regulation 61.56, was completed in a Bell 222U on December 9, 1999.

AIRCRAFT INFORMATION

The helicopter was a Bell 222U, serial number 47539. The Bell 222U is a utility version of the executive model Bell 222. The helicopter has a two-bladed rotor system and is powered by two 653 horsepower Lycoming LTS101-750C-1 turbo shaft engines. The accident helicopter was configured to accommodate a pilot and six passengers. The Bell 222U is equipped with a landing skid instead of a retractable landing gear and has additional fuel tanks located in both sponsons.

According to Federal Aviation Administration (FAA) records, the helicopter was owned by the Air Methods Corporation, Englewood, Colorado, and operated by an emergency medical service operator, Life Link III, of St. Paul, Minnesota. The helicopter was issued a FAA Standard Airworthiness Certificate on May 24, 1985, and was certified for transport category operations.

At the time of the accident, the helicopter had accumulated a total airframe time of 7,885.3 hours. The helicopter was maintained in accordance with an approved manufacture's inspection program and the last inspection was a 100-hour inspection. The last inspection was completed on March 23, 2000, and the helicopter had accumulated 39.2 hours since the inspection.

METEOROLOGICAL INFORMATION

A weather observation station, located at STP, approximately 2 nautical miles (nm) southeast of the accident site, reported the weather at 1553 as:

Observation Time:	1553
Wind:	350 degrees magnetic at 12 knots
Visibility:	10 statute miles
Sky Condition:	Sky Clear
Temperature:	16 degrees Celsius
Dew Point:	04 degrees Celsius
Pressure:	29.72 inches-of-mercury

COMMUNICATIONS

The STP air traffic control tower provided a copy of the voice communication tape that was recording the STP tower frequency at the time of the accident. According to the tape, the pilot of the accident helicopter had established two-way communications with the air traffic control tower prior to the accident. The helicopter was cleared to land and immediately after the air traffic controller's transmission there was a prolonged hot-mike transmission. The hot-mike transmission was approximately 35 seconds in duration and included periods of shouting and heavy breathing. Subsequent to the hot-mike transmission, no voice transmissions were received from the accident helicopter.

WRECKAGE AND IMPACT INFORMATION

The accident site was located on the roof of a two-story industrial warehouse. The helicopter was in an up-right position and was orientated on a southerly heading. All components of the helicopter were located at the accident site. The main cabin was undamaged. The helicopter skids were bent outward and the bottom of the helicopter was resting on the rooftop. The right sponson was crushed upward and the left sponson was undamaged. The tail boom was deformed near the intersection of the main cabin and the tail boom. The tail boom is an integral part of the helicopter airframe. The rotor mast remained attached to the transmission. Both main rotor blades remained attached to the rotor hub assembly and were not damaged. The main rotor hub droop stops were deformed and scraped. All pitch change linkages remained attached to the swash-plate assembly and blade grips. The tail-rotor drive shaft was not damaged. The tail rotor hub remained attached to the 90-degree gearbox and both tail rotor blades remained attached the rotor hub. The tail rotor blades were not damaged and all pitch change linkages were intact.

The pylon mounted actuator support assembly (Part # 222-040-125-001, Serial Number A-120) was separated from its mating surface on the transmission case. The support assembly is mounted on four dowel pins which line-up the support assembly to the transmission case. The support assembly is then bolted-down to the transmission case with eight threaded studs. The support assembly is the attachment point for the three actuation servos that control the cyclic pitch, cyclic roll, and collective positions. See attached diagrams appended to this factual report.

All four dowel pins were recovered. The first dowel pin remained intact and was still in the upper transmission case. The second dowel pin was found in the grease drop-pan, located below the transmission case, and was fractured. The third dowel pin was found on the cowl-ledge structure and was not visually fractured. A portion of the fourth dowel pin was located in the desk-drawer of the lead mechanic and was fractured. The lead mechanic reported that the dowel pin was found during routine maintenance on the helicopter, approximately one year prior to the accident date, and the maintenance staff did not determine the identity and source of the dowel pin.

Portions of all eight threaded studs were recovered from the grease drop-pan and all of the studs were fractured.

There was flexible sealant material (Pro-Seal) on the mating surfaces between the transmission case and the support assembly. The same material was found on the forward side of the support assembly where the dowel and treaded stud holes were located.

TESTS AND RESEARCH

The transmission, pylon mounted actuator support assembly with attachment hardware, and three actuation servos were removed from the helicopter for examination and testing.

The three actuation servos were examined and tested at a Bell Helicopter-Textron facility located in Hurst, Texas. The servos operated within the operational specifications as defined by Bell Helicopter-Textron.

The upper and lower transmission cases were sectioned and the forward portions of the cases were sent to the NTSB Materials Laboratory Division, Washington, D.C.. The pylon mounted actuator support assembly, the four dowel pins, and the eight threaded studs were also sent to the NTSB Materials Laboratory Division for examination.

According to the NTSB Materials Laboratory Factual Report, "... all of the studs showed progressive fatigue cracking from multiple origins." The report stated, "All but one stud fracture ... showed progression from diametrically opposed sides, typical of reversed bending fatigue loads." The report stated that the total extent of the fatigue progression, as a percent of the stud cross section, was greater than 75 percent for all eight studs and five of studs had greater than or equal to 90 percent fatigue propagation.

According to the NTSB Materials Laboratory Factual Report, all of the stud and dowel holes in the actuator support were, "... elongated on opposite sides from contact with the respective dowel or stud." The report stated, "In addition to the elongation of the holes, the faying surfaces of the support and the transmission case were severely worn from relative movement. The directions of indicated movements and wear correspond to the axis of elongation of the respective support holes."

The NTSB Materials Laboratory Factual Report is appended to this factual report.

According to the maintenance records for the accident helicopter, the pylon mounted actuator support assembly was installed on June 22, 1992, at a total airframe time of 4,876.1 hours. The support assembly was new at the time of installation and no maintenance entries were found subsequent to the installation of the support assembly. At the time of the accident, the support assembly had accumulated a total of 3,009.2 hours since the installation.

A review of the recommended and required Bell 222 maintenance procedures and directives was conducted. There were no maintenance procedures or directives for any inspection of the pylon mounted actuator support assembly when it was installed.

Subsequent to the accident, Bell Helicopter-Textron issued an Alert Service Bulletin that called for a one-time inspection of the installation of the actuator support assembly. The Alert Service Bulletin states, "The purpose of this bulletin is to require a one-time inspection of the hydraulic actuators support installation by accomplishing a torque check of the support attaching nuts. In addition, a Revision to the maintenance manual will introduce a recurring torque check of the support attaching nuts."

A copy of the Alert Service Bulletin is appended to this factual report.

Subsequent to the issuance of the Alert Service Bulletin, the Federal Aviation Administration issued Airworthiness Directive 2001-01-51, which called for the inspection of the actuator support assembly installation. As of the date of Airworthiness Directive 2001-01-51, the inspection must be completed within 25 hours time in service and thereafter cycles not to exceed 600 hours or 12 months, whichever occurs first.

A copy of Airworthiness Directive 2001-01-51 is appended to this factual report.

During October 1999, three Service Difficulty Reports (SDRs) concerning the installation of the Bell 222 actuator support assembly were submitted to the FAA. All three reports stated that there was a loss of torque on the actuator support assembly attachment nuts. Two of the three reports stated that the actuator support assembly mounting holes were elongated beyond serviceable limits. The three SDR reports were submitted to the local FAA Flight Standards District Office (FSDO) in Fort Worth, Texas. On November 4, 1999, the Fort Worth FSDO forwarded the SDR reports to the Rotorcraft Directorate in Fort Worth, Texas. On April 18, 2000, the Fort Worth FSDO resubmitted the SDR reports to the Rotorcraft Directorate in Fort Worth, Texas.

On April 20, 2000, the NTSB Investigator-In-Charge (IIC) requested that the FAA conduct a query of their SDR database to establish if there had been any prior service difficulties with the actuator support assembly. No SDR reports were listed on the query results that covered the actuator support assembly.

On April 8, 2002, the NTSB IIC requested that the FAA conduct another query of their SDR database to establish if the SDRs that were previous submitted were included in the SDR database. The query results had only one report, dated September 28, 2000, that covered the actuator support assembly.

ADDITIONAL INFORMATION

The helicopter was released on May 01, 2000, to a representative of the Air Methods Corporation. All retained components were returned on April 5, 2001, to a representative of the Air Methods Corporation.

Parties to the investigation were the FAA, Bell Helicopter-Textron, Honeywell, and the Air Methods Corporation.

Pilot Information

Certificate:	Commercial; Private	**Age:**	39,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:**	No
Medical Certification:	Class 1 Valid Medical--no waivers/lim.	**Last FAA Medical Exam:**	July 13, 1999
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	December 9, 1999
Flight Time:	3406 hours (Total, all aircraft), 359 hours (Total, this make and model), 87 hours (Last 90 days, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Bell	**Registration:**	N225LL
Model/Series:	222U 222U	**Aircraft Category:**	Helicopter
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Utility	**Serial Number:**	47539
Landing Gear Type:	Skid	**Seats:**	7
Date/Type of Last Inspection:	March 23, 2000 100 hour	**Certified Max Gross Wt.:**	8400 lbs
Time Since Last Inspection:	39.2 Hrs	**Engines:**	2 Turbo shaft
Airframe Total Time:	7885.3 Hrs at time of accident	**Engine Manufacturer:**	Lycoming
ELT:	Installed, not activated	**Engine Model/Series:**	LTS101-750C-1
Registered Owner:	Air Methods Corporation	**Rated Power:**	653 Horsepower
Operator:		**Operating Certificate(s) Held:**	On-demand air taxi (135)
Operator Does Business As:	LIFELINK III	**Operator Designator Code:**	QMLA

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	STP,705 ft msl	**Distance from Accident Site:**	2 Nautical Miles
Observation Time:	15:53 Local	**Direction from Accident Site:**	130°
Lowest Cloud Condition:	Clear	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	12 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	350°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.71 inches Hg	**Temperature/Dew Point:**	16°C / 4°C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	St. Paul, MN (PVT)	**Type of Flight Plan Filed:**	Company VFR
Destination:	(STP)	**Type of Clearance:**	VFR
Departure Time:	16:05 Local	**Type of Airspace:**	Class D

Wreckage and Impact Information

Crew Injuries:	1 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	1 None	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	2 None	**Latitude, Longitude:**	44.970703,-93.200332(est)

Administrative Information

Investigator In Charge (IIC):	Fox, Andrew
Additional Participating Persons:	Charles R Crary; Federal Aviation Administration - Minneapolis FSDO; Minneapolis, MN David C Dosker; Bell Helicopter - Textron; Fort Worth, TX Leroy Jackson; Air Methods Corporation; Englewood, CO Mike A Cummins; Honeywell - Engines & Systems; Phoenix, AZ
Original Publish Date:	June 3, 2002
Last Revision Date:	
Investigation Class:	Class
Note:	The NTSB traveled to the scene of this accident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=48962