National Transportation Safety Board
Aviation Accident Final Report

Location:	San Antonio, TX	**Accident Number:**	CEN16LA027
Date & Time:	11/02/2015, 1923 CST	**Registration:**	N496AE
Aircraft:	BELL 407	**Aircraft Damage:**	Substantial
Defining Event:	Aircraft structural failure	**Injuries:**	3 None
Flight Conducted Under:	Part 135: Air Taxi & Commuter - Non-scheduled - Air Medical (Discretionary)		

Analysis

The commercial pilot was conducting an emergency medical services flight. The pilot reported that, when he climbed the helicopter to a 3-ft hover, he heard a loud bang, and the helicopter began an uncommanded right yaw. The pilot applied full left pedal, but this did not arrest the yaw. The pilot then lowered the collective, and the helicopter touched down and then rotated 270 degrees to the right before it came to a stop.

The tail rotor was examined, and it could be manually rotated, but a grinding noise could be heard coming from the damaged No. 3 hanger bearing. The main rotor blades did not rotate in synchronization with the tail rotor blades. The No. 3 tail rotor shaft adapter and shaft splines were completely ground down, the adapter and shaft had failed, and there was evidence of excessive torsion beyond the intended allowable tolerances. The aluminum adapter washer hole was elongated, consistent with a loose through bolt, and the drive shaft through bolt had worn threads. There was a 1/8-inch gap between the adapter and the base of the hanger bearing, consistent with the adapter not being fully in contact with the bearing and potential stress within the adapter and shaft splines. The retaining nut had migrated almost .025 inch outward and was very loose, consistent with the loss of torque, which would have allowed movement between the tail rotor adapter and shaft and led to their eventual failure. A review of the helicopter maintenance manual and operator's approved aircraft inspection program revealed that neither had a requirement for the tail rotor assembly to be inspected for security.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The failure of the No. 3 tail rotor adapter and shaft due to a loss of torque on the retaining nut. Contributing to the accident was the lack of a requirement to inspect the tail rotor assembly for security in the helicopter manufacturer’s maintenance manual and the operator's approved aircraft inspection program.

Findings

Aircraft	Tail rotor drive shaft - Fatigue/wear/corrosion (Cause) Tail rotor drive shaft - Failure (Cause)
Organizational issues	Adequacy of policy/proc - Manufacturer (Factor) Adequacy of policy/proc - Operator (Factor)

Factual Information

On November 2, 2016, at 1923 central standard time, the pilot of a Bell 407, N496AE, made a forced landing at San Antonio International Airport (KSAT), San Antonio, Texas. The pilot, flight nurse, and paramedic were not injured. The helicopter was substantially damaged. The helicopter was registered to and operated by AirEvac EMS, Inc., (EVCA), O'Fallon, Missouri, under the provisions of 14 Code of Federal Regulations Part 135 as an on-demand air medical flight. Night visual meteorological conditions prevailed at the time of the accident, and no flight plan had been filed. The flight was originating from KSAT, and was destined for Northeast Methodist Hospital (XS83), San Antonio.

When the pilot lifted helicopter to a 3-foot hover, he heard a loud bang and the helicopter began an uncommanded right yaw. The pilot applied full left pedal, but this did not arrest the yaw. The pilot then lowered the collective and the helicopter touched down, rotating 270 degrees to the right before coming to a stop. Post-accident examination revealed substantial damage to the tail rotor spline, coupling, and hanger bearings.

Postaccident examination revealed the tail rotor could be manually rotated, but a grinding noise could be heard coming from the damaged no. 3 hanger bearing. The main rotor blades did not rotate in synchronization with the tail rotor blades. The #3 tail rotor shaft adapter and shaft splines were completely ground down, and the adapter and the tail rotor shaft connecting point had failed. There was evidence of excessive torsion, beyond its intended allowable tolerances. There was excessive grease on the hanger bearing. The aluminum adapter washer hole was elongated, consistent with of a loose through-bolt. There was a 1/8th inch gap between the adapter and the base of the hanger bearing, consistent with the adapter not being fully in contact with the bearing and potential stress within the adapter and shaft splines. The smaller, stainless steel washer was mushroom-shaped. The drive shaft through-bolt had worn threads.

On November 18 and 19, 2105, the tail rotor assembly was examined at the facilities of Able Engineering, Mesa, Arizona, under the auspices of an FAA aviation safety inspector from the Scottsdale, Arizona, FSDO. Bell Helicopters and AirEvac EMS also participated in the examination. The shaft, freewheeling unit and tail gear box were examined. No issues were noted except for the failed coupling and shaft. The retaining stud had migrated almost .025" outward and was very loose compared to the others, consistent with the loss of torque that would have allowed movement between the coupling and shaft and eventual failure.

After the examination, Air Evac EMS ordered an inspection of their entire Bell 407 fleet. Two helicopters were found to have loose tail rotor drive shafts. The drive shaft, carrier bearing, coupling, and spline from one of those helicopters were examined the next day. The retaining nut was loose. Torque was measured at 20 inch-pounds. Minimum torque is 30 to 50 inch-pounds. Tare was 5 to 0 inch-pounds. Stud extension was within millimeter limits. There was a slight motion between the coupling face and the face of the bearing. This motion had worn the coupling face and there was slight wear on some of the splines. In the Bell 407 Maintenance Manual and Air Evac EMS' AAIP, there is no requirement for the assembly to be inspected for security.

History of Flight

Maneuvering-hover	Aircraft structural failure (Defining event)

Pilot Information

Certificate:	Commercial	**Age:**	32, Male
Airplane Rating(s):	None	**Seat Occupied:**	Right
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	
Instrument Rating(s):	Helicopter	**Second Pilot Present:**	No
Instructor Rating(s):	Instrument Helicopter	**Toxicology Performed:**	No
Medical Certification:	Class 1 Without Waivers/Limitations	**Last Medical Exam:**	04/16/2015
Occupational Pilot:	Yes	**Last Flight Review or Equivalent:**	10/15/2015
Flight Time:	2201 hours (Total, all aircraft), 28 hours (Total, this make and model), 1207 hours (Pilot In Command, all aircraft), 97 hours (Last 90 days, all aircraft), 2626 hours (Last 30 days, all aircraft), 1 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Manufacturer:	BELL	**Registration:**	N496AE
Model/Series:	407	**Aircraft Category:**	Helicopter
Year of Manufacture:		**Amateur Built:**	No
Airworthiness Certificate:	Normal	**Serial Number:**	53328
Landing Gear Type:	High Skid	**Seats:**	4
Date/Type of Last Inspection:	11/02/2015, AAIP	**Certified Max Gross Wt.:**	5250 lbs
Time Since Last Inspection:		**Engines:**	1 Turbo Shaft
Airframe Total Time:	7939 Hours	**Engine Manufacturer:**	Rolls Royce
ELT:	C126 installed, not activated	**Engine Model/Series:**	M250-C47B
Registered Owner:	Air Evac EMS, Inc.	**Rated Power:**	630 hp
Operator:	Air Evac EMS, Inc.	**Air Carrier Operating Certificate:**	On-demand Air Taxi (135)
Operator Does Business As:		**Operator Designator Code:**	EVCA

Meteorological Information and Flight Plan

Observation Facility, Elevation:	KSAT, 809 ft msl	**Observation Time:**	1851 CST
Distance from Accident Site:	0 Nautical Miles	**Condition of Light:**	Night
Direction from Accident Site:		**Conditions at Accident Site:**	Visual Conditions
Lowest Cloud Condition:	Clear	**Temperature/Dew Point:**	21°C / 12°C
Lowest Ceiling:	None	**Visibility**	10 Miles
Wind Speed/Gusts, Direction:	5 knots, 130°	**Visibility (RVR):**	
Altimeter Setting:	29.95 inches Hg	**Visibility (RVV):**	
Precipitation and Obscuration:			
Departure Point:	San Antonio, TX (KSAT)	**Type of Flight Plan Filed:**	Company VFR
Destination:	San Antonio, TX (XS83)	**Type of Clearance:**	VFR
Departure Time:	1923 CST	**Type of Airspace:**	Class C

Airport Information

Airport:	San Antonio International (KSAT)	**Runway Surface Type:**	
Airport Elevation:	809 ft	**Runway Surface Condition:**	Dry
Runway Used:	N/A	**IFR Approach:**	None
Runway Length/Width:		**VFR Approach/Landing:**	Forced Landing

Wreckage and Impact Information

Crew Injuries:	1 None	**Aircraft Damage:**	Substantial
Passenger Injuries:	2 None	**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	3 None		

Administrative Information

Investigator In Charge (IIC):	Arnold W Scott	**Adopted Date:**	08/01/2016
Additional Participating Persons:	Jesse Sanchez; FAA Flight Standards District Office; San Antonio, TX Mark Pritchett; FAA Flight Standards District Office; Scottsdale, AZ Tony Bonham; Air Evac EMS; O'Fallon, MO Aaron Slager; Bell Helicopters, Inc.; Fort Worth, TX		
Publish Date:	08/01/2016		
Note:	The NTSB did not travel to the scene of this accident.		
Investigation Docket:	http://dms.ntsb.gov/pubdms/search/dockList.cfm?mKey=92279		

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