

Aviation Investigation Final Report

Location:	Vermillion 44,	Accident Number:	FTW01FA115
Date & Time:	May 4, 2001, 16:16 Local	Registration:	N917AL
Aircraft:	Bell 407	Aircraft Damage:	Substantial
Defining Event:		Injuries:	2 None
Flight Conducted Under:	Part 135: Air taxi & commuter - Non-scheduled		

Analysis

While in cruise flight, the pilot reported that a "slight vibration became noticeable." After a few minutes, the vibration became more pronounced, and was accompanied by a noise. During an attempted precautionary landing to an offshore platform, the vibration and noise level increased again, and total engine power was lost. The pilot then initiated an autorotation to the water, deployed the skid floats, and landed safely. While the helicopter was being towed in the water, the helicopter rolled inverted. Examination of the helicopter after recovery revealed that the KAflex engine-to-transmission driveshaft was fractured, and the forward tail rotor driveshaft segment was separated. Examination of the KAflex driveshaft revealed fatigue fractures that originated from a bolt hole in the first flex frame of the coupling at the transmission end of the shaft and fatigue fractures in the end fitting at the transmission end. The primary fracture was a fatigue crack that occurred in a bolt hole where a bolt joined the first flex frame to the center flex frame. The driveshaft was determined to be manufactured within engineering specifications. The fractured tail rotor driveshaft showed evidence of torsional overstress. The KAflex driveshaft coupling had a total time of 2,114.2 hours and an airworthiness life limit of 5,000 hours. Following the accident, the manufacturer issued a service bulletin introducing a new KAflex driveshaft with a 1,250-hour overhaul interval.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: Failure of the engine-to-transmission driveshaft coupling due to fatigue.

Findings

Occurrence #1: AIRFRAME/COMPONENT/SYSTEM FAILURE/MALFUNCTION Phase of Operation: CRUISE

Findings

1. (C) ROTOR DRIVE SYSTEM, ENGINE TO TRANSMISSION DRIVE - FATIGUE

2. (C) ROTOR DRIVE SYSTEM, ENGINE TO TRANSMISSION DRIVE - FRACTURED

3. ROTOR DRIVE SYSTEM, TAIL ROTOR DRIVE SHAFT - SEPARATION

Occurrence #2: FORCED LANDING Phase of Operation: EMERGENCY DESCENT/LANDING

Findings

4. AUTOROTATION - PERFORMED - PILOT IN COMMAND

5. TERRAIN CONDITION - WATER

Factual Information

HISTORY OF FLIGHT

On May 4, 2001, at 1616 central daylight time, a Bell 407 single-engine helicopter, N917AL, sustained substantial damage due to a drive shaft component failure while operating off shore in the Gulf of Mexico. The commercial pilot and his passenger were not injured. The helicopter was registered to and operated by Air Logistics LLC, of New Iberia, Louisiana. Visual meteorological conditions prevailed and a company visual flight rules flight plan was filed for the 14 Code of Federal Regulations Part 135 on-demand air taxi flight. The helicopter departed the High Island 368 offshore platform at 1535, and was destined for Intracostal City, Louisiana.

In an interview with the NTSB investigator-in-charge (IIC), the pilot reported that while in cruise flight at 700 feet agl, enroute from High Island 368 to Intracoastal City, a "slight vibration became noticeable." After a few minutes, the vibration became more pronounced, and was accompanied by a noise. During an attempted precautionary landing to an offshore platform, the vibration and noise level increased again, and total engine power was lost. The pilot then initiated an autorotation to the water, deployed the skid floats, and landed safely. After landing, the pilot retarded the throttles, shut off the fuel valve and placed the electrical switches to the OFF position. While the helicopter was being towed in the water, the helicopter rolled over inverted. Examination of the helicopter, after recovery by the operator, revealed that the KAflex engine-to-transmission driveshaft had fractured, and the forward section of the tail rotor driveshaft had separated.

PERSONNEL INFORMATION

The pilot held an airline transport pilot certificate with helicopter, airplane single-engine land and multi-engine land ratings. In addition, he held helicopter and airplane instrument ratings. The pilot was issued a second-class medical certificate on March 8, 2001, with the limitation, "Glasses near and intermediate." His total flight time, as of May 4, 2001, was 15,100 hours, of which 2,800 hours were in the Bell 407. He had flown 166 operational flight hours in the Bell 407 during the 90 days prior to the accident.

AIRCRAFT INFORMATION

Manufactured at Bell Helicopter Textron Canada (BHTC), the Bell model 407 helicopter, S/N 53381, was certified on September 15, 1999, and delivered to Air Logistics L.L.C., of New Iberia, on September 21, 1999, with 14.6 total flight hours. The helicopter was powered by a 630 horsepower turboshaft Rolls Royce Allison 250-C-47B engine, S/N CAE-847417. According to records provided by the operator, the helicopter had accumulated 2,114.2 total

flight hours, 1,771 total cycles, and 4,476 total takeoffs at the time of the accident.

The maintenance records revealed that the fractured KAflex driveshaft, P/N 206-340-300-105, S/N KC734, was last removed and reinstalled on the helicopter on April 10, 2001, at a helicopter time of 1,998 hours. The KAflex driveshaft is often removed when maintenance is performed near the transmission area, pylon mounts, engine, etc. The records indicated that the helicopter's KAflex driveshaft had been removed and reinstalled nine times for both scheduled and unscheduled maintenance prior to accident. The KAflex driveshaft had a total time of 2,114.2 hours and an airworthiness life limit of 5,000 hours.

According to the BHTC maintenance manual, each end of the KAflex driveshaft is comprised of four rectangular flex frames that are attached with bolts to each other and to each end of the shaft. A flange adapter is attached to each flex frame assembly with bolts. One flange adapter bolts to the transmission input adapter, and the other flange adapter bolts to the rotor disk and to the freewheel adapter. The driveshaft turns at 6,317 rpms and transmits the power from the engine to the transmission. The driveshaft is designed to flex to accommodate the misalignment between the engine and transmission that occurs during operation. According to Transport Canada (TC), three incidents involving cracked flex frames on the forward (transmission) end of the driveshaft had previously been reported.

WRECKAGE AND IMPACT INFORMATION

Initial examination of the wreckage was conducted by the NTSB at the operator's base in New Iberia, on May 8, 2001. The helicopter's fuselage and tail boom were predominately intact. The chin bubbles, forward windscreens, and skid gear floats were damaged during recovery. The mast and rotor system were removed from the helicopter prior to the examination and were also substantially damaged during the recovery. The upper cowlings, with the exception of the hydraulic flight control actuators' cowling, were removed prior to the examination. The engine was observed mounted to the airframe and the engine mounts were found to be secure. The steel tail rotor drive shaft had been torsionally separated approximately 2 inches forward of the dynamic balance weight. The tail rotor gearbox case displayed evidence of saltwater corrosion, and the tail rotor hub and blades were securely mounted to the output shaft with no anomalies noted. The cockpit controls were manually manipulated with no anomalies noted, and continuity was established from the cockpit throughout the entire flight control system. The cockpit switch positions were all in their normal shutdown positions, with the exception of the hydraulic system and the avionics master switches, which were ON. The only open circuit breaker was the GPS circuit breaker.

The KAflex driveshaft was found separated from the transmission input side. The anti-flail device was observed separated from the transmission side of the driveshaft. Separated portions of the driveshaft flex frames were found on the roof deck. The roof deck immediately below the transmission end of the driveshaft had been punctured and displayed signatures of rotational scoring and tearing. In addition, the fuel vent line had been punctured. The oil line that connects to the oil manifold for the freewheeling unit had also been severed. The

driveshaft and its fractured components, along with the separated forward tail rotor drive shaft, were retained by the NTSB for further examination.

TESTS AND RESEARCH

On May 17, 2001, at the facilities of Bell Helicopter, Hurst, Texas, under the supervision of the NTSB, the KAflex driveshaft and tail rotor driveshaft were examined by Bell engineers. Bell Helicopter's materials laboratory examination of the KAflex driveshaft "revealed fatigue fractures at a bolt hole in the first flex frame at the transmission end of the shaft and fatigue fractures in the end fitting at the transmission end. The primary fracture was a fatigue crack that occurred in a bolt hole where a bolt joined the first flex frame to the center flex frame. All the other fractures were a result of overstress." The driveshaft was determined to be manufactured within engineering specifications.

Bell Helicopter's materials laboratory report also stated that "the fractured tail rotor driveshaft was a result of torsional overstress. The direction of overstress was consistent with restraint of the driveshaft from the flywheel aft while the forward portion of the shaft was driven in a clockwise direction as viewed looking forward."

ADDITIONAL INFORMATION

Transport Canada issued Airworthiness Directive (AD) CF-2001-24 on June 11, 2001. The AD discussed this accident and three other incidents involving cracked flex frames on the driveshaft. The AD required a one-time visual inspection for any obvious discrepancy of the driveshaft: "(a) within the next 25 hours air time for shafts with more than 1,000 hours, and for shafts with less than 1,000 hours which have been removed or installed since the helicopter was delivered; (b) or within the next 300 hours for shafts with less than 1,000 hours that have never been removed or installed since delivery." The one-time inspection was to be conducted in accordance with Bell Helicopter Alert Service Bulletin (ASB) 407-01-43, dated June 8, 2001. The ASB discussed the possibility of driveshaft failure due to fatigue cracking of the flex frames. The Federal Aviation Administration (FAA) issued AD 2001-13-51, dated June 27, 2001, which addressed the same subject matter as TC's CF-2001-24 AD and utilized the same inspection requirements and intervals.

Transport Canada also issued AD CF-2002-03, effective on February 28, 2002. The AD discussed this accident and the three additional incidents of cracked driveshaft flex frames. The AD stated that: "It has been determined that the KAflex driveshaft on model 407 helicopters is experiencing higher loads than on other helicopter models. Since the KAflex shaft P/N 206-340-3---105 can also be installed on Models 206L-4 and 427, this directive requires a component review to determine if the KAflex shaft was previously installed on Model 407." The corrective actions called for in the AD were:

"Part 1. Models 206L-4 and 427

Review of the Historical Service Record of the KAflex driveshaft to determine if it was ever installed on a Bell Model 407 helicopter:

(a) If the KAflex driveshaft has never been installed on a Bell Model 407 helicopter, then annotate the helicopter log book as follows: P/N 206-340-300-105 KAflex driveshaft has not been installed on a Bell 407. AD CF-2002-03 accomplished;

(b) If the KAflex driveshaft P/N 206-340-300-105 has been previously installed for any length of time on a Bell 407 helicopter, remove from service as per the applicable schedule published in BHTC Alert Service Bulletin 206L-01-123 or 427-01-45, both dated 12 October 2001, or later revisions approved by the Director, Aircraft Certification, Transport Canada."

Part 2. Model 407

Remove shaft P/N 206-340-300-105 as per the compliance schedule provided in BHTC Alert Service Bulletin 407-01-45 Rev "A" dated 21 November 2001, or later revisions approved by the Director, Aircraft Certification, Transport Canada.

The BHTC ASB 407-01-45 was issued to introduce the a new engine-to-transmission driveshaft, P/N 206-340-300-107, with a 1,250-hour overhaul interval and end identification marks. The bulletin requires the removal of driveshafts 206-340-300-105 per a described compliance schedule. The overhauled driveshafts are renumbered and retain an airworthiness life limit of 5,000 hours from new.

At the time of this writing, the FAA has not adopted an AD regarding Transport Canada's AD CF-2002-03.

The helicopter was released to the owner.

Pilot Information

Certificate:	Airline transport	Age:	51,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 2 Valid Medicalw/ waivers/lim	Last FAA Medical Exam:	March 8, 2001
Occupational Pilot:	Yes	Last Flight Review or Equivalent:	March 24, 2001
Flight Time:	15100 hours (Total, all aircraft), 2800 hours (Total, this make and model), 14100 hours (Pilot In Command, all aircraft), 180 hours (Last 90 days, all aircraft), 72 hours (Last 30 days, all aircraft), 6 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Bell	Registration:	N917AL
Model/Series:	407	Aircraft Category:	Helicopter
Year of Manufacture:		Amateur Built:	
Airworthiness Certificate:	Normal	Serial Number:	53381
Landing Gear Type:	Skid	Seats:	7
Date/Type of Last Inspection:	April 1, 2001 AAIP	Certified Max Gross Wt.:	5250 lbs
Time Since Last Inspection:	139 Hrs	Engines:	1 Turbo shaft
Airframe Total Time:	2114.2 Hrs at time of accident	Engine Manufacturer:	Rolls Royce Allison
ELT:	Installed, not activated	Engine Model/Series:	250-C-47B
Registered Owner:	Air Logistics L.L.C.	Rated Power:	630 Horsepower
Operator:		Operating Certificate(s) Held:	On-demand air taxi (135)
Operator Does Business As:		Operator Designator Code:	ALGL

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	Condition of Light:	Day
Observation Facility, Elevation:		Distance from Accident Site:	
Observation Time:		Direction from Accident Site:	
Lowest Cloud Condition:	Clear	Visibility	10 miles
Lowest Ceiling:	None	Visibility (RVR):	
Wind Speed/Gusts:	/	Turbulence Type Forecast/Actual:	/
Wind Direction:		Turbulence Severity Forecast/Actual:	/
Altimeter Setting:		Temperature/Dew Point:	28°C
Precipitation and Obscuration:	No Obscuration; No Precipitat	tion	
Departure Point:	HI-338, GM (368)	Type of Flight Plan Filed:	VFR
Destination:	Intercoastal , LA (7RA)	Type of Clearance:	Unknown
Departure Time:	15:35 Local	Type of Airspace:	Class G

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:	29.433332,-92.5

Administrative Information

Investigator In Charge (IIC):	Lemishko, Alexander
Additional Participating Persons:	Mark S Evans; FAA FSDO; Baton Rouge, LA Mattew Rigsby; Bell Helicopter Textron Canada; Fort Worth, TX Gary Tucker; Air Logistics, L.L.C.; Lafayette, LA Jeffery M Post; Kamatics Corporation; Bloomfield, CT
Original Publish Date:	April 29, 2003
Last Revision Date:	
Investigation Class:	<u>Class</u>
Note:	
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=52205

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.