Aviation Investigation Final Report

Location:	Holliday, Texas	**Accident Number:**	FTW04LA111
Date & Time:	April 21, 2004, 10:45 Local	**Registration:**	N9030Z
Aircraft:	Brantly Helicopter B-2B	**Aircraft Damage:**	Substantial
Defining Event:		**Injuries:**	2 Minor
Flight Conducted Under:	Part 91: General aviation - Instructional		

Analysis

The 14,600-hour flight instructor was providing the 3,600-hour commercial pilot flight instruction when the helicopter began a slow, uncommanded right turn that could not be arrested with left anti-torque pedal. As the flight instructor leveled the helicopter to land, he closed the throttle, added more collective, and contacted the ground in a sideward motion and rolled over. Examination of the helicopter revealed that the upper tail rotor shaft had completely sheared off at the upper bevel gear bolt hole. A review of the maintenance records revealed the helicopter had previously experienced two hard landings and this was the second time the shaft had failed. In a separate incident, another B-2B owner reported an upper tail rotor shaft failure while in a low hover. However, there was no history of any hard landings. Both failed upper tail rotor shafts were sent to the Safety Board's Materials Laboratory, Washington DC, for examination. Results of the examination revealed that both upper shafts failed due to fatigue at the bolt hole where the shaft attached to the bevel gear. The area outside both bolt holes exhibited fretting, gouging and pitting, which resulted in a fatigue crack and subsequent torsional shear of the shafts. The manufacturer conducted an engineering study and concluded that the most probable cause for the upper tail rotor shafts failing was excessive misalignment due to external forces or improper maintenance. A review of the maintenance manual revealed there was information for inspections after a hard landing but there were no specific procedures for checking the alignment of the upper tail rotor shaft. As a result of the investigation, the manufacturer issued Service Bulletin Number 105: Tail Rotor Drive System Inspection, which directed owners to inspect the condition of the upper tail rotor shaft and parts in that assembly. In addition, they issued Service Instruction Number 10, which described maintenance procedures to remove, disassemble and then reassemble and install the upper tail rotor gearbox. At the time of this report, the manufacturer was scheduled to release Service Instructions Number 11 and 12, and also Service Bulletin Number 106. They have requested the FAA to upgrade Service Bulletin Number 106 to an Airworthiness Directive (AD), which would require all owners to inspect the dimensions that affect the alignment of the upper tail rotor shaft. If any of the shafts were found to have operated outside of the

alignment tolerances they would have to be replaced.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be: The failure of the upper tail rotor shaft due to excessive misalignment after two hard landings. Also causal was the manufacturer's failure to provide specific maintenance procedures for checking the alignment of the upper tail rotor shaft.

Findings

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

Findings
1. (C) ROTOR DRIVE SYSTEM,TAIL ROTOR DRIVE SHAFT - SHEARED
2. (C) ROTOR DRIVE SYSTEM,TAIL ROTOR DRIVE SHAFT - FATIGUE
3. (C) MAINTENANCE,ALIGNMENT - EXCESSIVE
4. (C) CONDITION(S)/STEP(S) INSUFFICIENTLY DEFINED - MANUFACTURER

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

Occurrence #3: ON GROUND/WATER ENCOUNTER WITH TERRAIN/WATER
Phase of Operation: EMERGENCY LANDING

Findings

5. TERRAIN CONDITION - GROUND

Occurrence #4: ROLL OVER
Phase of Operation: EMERGENCY LANDING

Factual Information

HISTORY OF FLIGHT

On April 21, 2004, at 1045 central daylight time, a Brantly B-2B helicopter, N9030Z, was substantially damaged during a forced landing to a field near Holliday, Texas. The airline transport pilot (ATP) and the commercial pilot receiving instruction sustained minor injuries. The helicopter was registered to Brantly International Incorporated, of Vernon, Texas, and was being operated by the airline transport pilot. Visual meteorological conditions prevailed and no flight plan was filed for the instructional flight conducted under 14 Code of Federal Regulations Part 91. The local flight originated at Kickapoo Downtown Airport (T47), near Wichita Falls, Texas, about 1010.

In a written statement, the ATP said he was providing flight instruction to the commercial pilot when the accident occurred. While the commercial pilot was performing normal climbs and descents at a constant airspeed of 60 miles per hour (mph), an abnormal engine/vibration developed, followed by a "quick, almost jerk" yawing motion. The ATP took control of the helicopter, initiated a power reduction, and started a descent. He reported that he "put the collective on the floor " and descended at an airspeed about 60 mph. During the descent, the yaw control felt sluggish, and the helicopter continued in a shallow right turn as they descended. As the helicopter approached the ground, the ATP flared the helicopter to dissipate forward airspeed. As he added collective during the flare, the helicopter continued to turn to the right, and when he applied left anti torque pedal, it did not arrest the situation. As he leveled the helicopter to land, he closed the throttle, added more collective, and the helicopter impacted the ground in a sideward motion. Subsequently, the helicopter rolled on to its left side.

The commercial pilot receiving instruction reported a similar account as the ATP. He stated that while maneuvering about 500 feet above the ground, he felt a low frequency vibration below his seat (right side) followed by an uncommanded right turn, which could not be corrected when he applied left anti-torque pedal. The ATP took control of the helicopter and attempted to set it down. As the helicopter approached the ground, it continued to turn to the right approximately 180 degrees. The ATP flared the helicopter about 4 to 6 feet above the ground but, it was drifting to the left and turning slightly to the right when it impacted the ground and subsequently rolled over.

A Federal Aviation Administration (FAA) inspector performed an initial on-scene examination of the helicopter. He reported the helicopter came to rest on its left side, and two of the three main rotor blades were broken at mid-span, and the other blade exhibited damage. The tail boom and tail rotors were not damaged. Upon completion of the on-scene examination and after the helicopter was recovered, personnel from the FAA's Rotorcraft Certification Office

performed another examination of the helicopter. This examination revealed that the tail rotor upper tail rotor shaft had completely sheared off at the upper bevel gear bolt hole.

On June 22, 2004, the airframe manufacturer notified the Safety Board that the owner of another B-2B helicopter, N9023Z, had reported a upper tail rotor shaft failure while the helicopter was at a low hover. The pilot landed safely with minimal damage to the helicopter. The owner sent the fractured upper tail rotor shaft to the Safety Board where it was examined along with the other fractured drive shaft.

PERSONNEL INFORMATION

The airline transport pilot held a flight instructor certificate for airplane single and multi-engine land, rotorcraft-helicopter and instrument airplane and helicopter. His most recent FAA second-class medical was issued on March 29, 2004. He reported a total of 14,600 flight hours, 2,000 flight hours in helicopters; of which, 1,000 flight hours were in the same make and model.

The commercial pilot also held a flight instructor certificate for airplane single and multi-engine land, and instrument airplane. His most recent FAA second-class medical was issued on February 6, 2003. He reported a total of 3,900 flight hours, and was receiving instruction to become a helicopter flight instructor. The commercial pilot estimated that he had two hours in same make and model.

AIRCRAFT INFORMATION

N9030Z (serial number 2014) was manufactured in 2000. A review of the maintenance records revealed the helicopter experienced a previous hard landing on June 27, 2000, at an airframe total time of 47.2 hours. The aircraft was reported to have sustained twisting damage to the tail cone in between the horizontal stabilizers and the tail pylon. The tail cone was removed and replaced, and the drive link components were examined for damage and none was found. The tail rotor drive system was reinstalled and a hard landing inspection was completed in accordance with the Brantly B-2B Maintenance Manual. No other damage was found.

On April 25, 2003, the helicopter experienced another hard landing and possible tail rotor strike, at an aircraft total time of 456.9 hours. The helicopter was again inspected, the tail rotor blades were removed and new ones were installed. The helicopter was returned to service.

On February 2, 2004, the upper tail rotor shaft (Part Number 249-10) failed at an aircraft total time of 512.5 hours, 55.6 hours after the second hard landing. The broken shaft was removed, discarded and replaced. On April 21, 2004, the upper tail rotor shaft failed again 43.4 hours after it was replaced in February 2004. At the time of the accident, the helicopter had accrued a total of 555.9 hours.

N9023Z (serial number 2021) was manufactured in 2001. A review of the maintenance records revealed the helicopter had accrued a total of approximately 350 hours when the upper tail rotor shaft failed. However, there was no history of a hard landing or that the upper tail rotor shaft assembly had been replaced.

According to the owner, he had recently purchased the helicopter from a company based in Louisiana and had it transported to Michigan via a trailer. About 15 minutes into his first flight, the upper tail rotor shaft failed while in a low hover and he was able to land safely with minimal damage to the helicopter.

METEOROLOGICAL INFORMATION

Weather at Kickapoo Downtown Airport, near Wichita Falls, Texas, at 1052, was wind from 200 degrees at 9 knots, visibility 10 statute miles, and few clouds at 15,000 feet. The temperature was 73 degrees Fahrenheit and the dewpoint was 61 degrees Fahrenheit.

TESTS AND RESEARCH

Both failed upper tail rotor shafts were sent to the Safety Board's Materials Laboratory, in Washington DC, for further examination. Results of the examination revealed that both upper shafts failed due to fatigue at the bolt hole where the shaft attached to the bevel gear. The area outside both bolt holes exhibited fretting, gouging and pitting, which resulted in a fatigue crack and subsequent torsional shear of the shafts.

ADDITIONAL INFORMATION

Brantly International, Inc. conducted an in-depth engineering study and concluded that the most probable cause for the upper tail rotor shafts failing was excessive misalignment due to external forces (i.e. hard landing) and/or improper maintenance. A review of the Brantly Maintenance Manual revealed there was information for inspections after a hard landing but there were no specific procedures for checking the alignment of the upper tail rotor shaft. Brantly also stated that a hard landing could result in damage to fatigue critical parts (i.e. shafts), permanently distort structure and affect the loads on fatigue critical parts (i.e. excessive misalignments), and also weaken the structure in a way that it would temporarily distort under flight loads and exaggerate a misalignment (i.e. working rivets).

As a result of the investigation, the FAA Aircraft Certification Office, Washington, DC, issued Service Alert Information Bulletin (SAIB) Number SW-04-90, which alerted owners and operators of Brantly International, Inc, B-2, B-2A, B-2B model helicopters, that three upper tail rotor shaft failures had occurred since February 2, 2004. The SAIB provided a background of the incidents and provided non-mandatory recommendations to owners/operators to remove and inspect the upper tail rotor drive shaft within the next 10 hours time-in-service (TIS). In addition the bevel gear, the flange bushing, the bolt, and the nut were also to be removed and inspected. The SAIB also suggested that the operator check maintenance logbooks for any

history of hard landings and make sure all drive shaft hardware was properly installed and aligned.

On August 3, 2005, Brantly International, Inc. issued Service Bulletin Number 105: Tail Rotor Drive System Inspection. The inspection was approved by the FAA and was to be completed within the next 10 hours TIS. The purpose of this service bulletin was to inspect the condition of the upper tail rotor shaft and parts in that assembly. The inspections were separated into two parts. Part One contained one-time inspections that had to be repeated only under certain circumstances. Part two contained inspections that had to be repeated periodically and under certain circumstances.

On September 14, 2005, Brantly issued Service Instruction Number 10, which superceded information in maintenance manuals dated prior to the date listed above. The service instruction will eventually be integrated into a future revision of the maintenance manual. The purpose of the service instruction was to describe in sufficient detail all the steps needed to remove, disassemble and then reassemble and install the upper tail rotor gearbox. This service instruction also clarified which parts could be replaced without having to change a higher assembly. Also, it described how to perform any special operations involved in replacing parts.

At the time of this report, Brantly International, Inc. is scheduled to release Service Instructions Number 11 and 12, and also Service Bulletin Number 106. They have requested the FAA to upgrade Service Bulletin Number 106 to an Airworthiness Directive (AD), which would require all owners to inspect the dimensions that affect the alignment of the upper tail rotor shaft. If any of the shafts were found to have operated outside of the alignment tolerances then it would have to be replaced.

Pilot Information

Certificate:	Airline transport; Commercial; Flight instructor	**Age:**	42,Male
Airplane Rating(s):	Single-engine land; Multi-engine land	**Seat Occupied:**	Left
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	
Instrument Rating(s):	Airplane; Helicopter	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane multi-engine; Airplane single-engine; Helicopter; Instrument airplane; Instrument helicopter	**Toxicology Performed:**	No
Medical Certification:	Class 2 With waivers/limitations	**Last FAA Medical Exam:**	March 1, 2004
Occupational Pilot:	UNK	**Last Flight Review or Equivalent:**	March 1, 2004
Flight Time:	14600 hours (Total, all aircraft), 1000 hours (Total, this make and model), 14400 hours (Pilot In Command, all aircraft), 100 hours (Last 90 days, all aircraft), 30 hours (Last 30 days, all aircraft), 4 hours (Last 24 hours, all aircraft)		

Pilot Information

Certificate:	Commercial; Flight instructor	**Age:**	67,Male
Airplane Rating(s):	Single-engine land; Single-engine sea; Multi-engine land	**Seat Occupied:**	Right
Other Aircraft Rating(s):	Helicopter	**Restraint Used:**	
Instrument Rating(s):	Airplane	**Second Pilot Present:**	Yes
Instructor Rating(s):	Airplane multi-engine; Airplane single-engine; Instrument airplane	**Toxicology Performed:**	No
Medical Certification:	Class 3 With waivers/limitations	**Last FAA Medical Exam:**	February 1, 2004
Occupational Pilot:	UNK	**Last Flight Review or Equivalent:**	March 1, 2004
Flight Time:	3900 hours (Total, all aircraft), 2 hours (Total, this make and model), 3500 hours (Pilot In Command, all aircraft), 18 hours (Last 90 days, all aircraft), 12 hours (Last 30 days, all aircraft), 5 hours (Last 24 hours, all aircraft)		

Aircraft and Owner/Operator Information

Aircraft Make:	Brantly Helicopter	**Registration:**	N9030Z
Model/Series:	B-2B	**Aircraft Category:**	Helicopter
Year of Manufacture:		**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	2014
Landing Gear Type:	Skid	**Seats:**	2
Date/Type of Last Inspection:	April 1, 2004 Annual	**Certified Max Gross Wt.:**	1670 lbs
Time Since Last Inspection:	5 Hrs	**Engines:**	1 Reciprocating
Airframe Total Time:	555 Hrs as of last inspection	**Engine Manufacturer:**	Lycoming
ELT:	Not installed	**Engine Model/Series:**	IO-360
Registered Owner:	Brantly International, Inc	**Rated Power:**	180
Operator:	Kevin Hines	**Operating Certificate(s) Held:**	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual (VMC)	**Condition of Light:**	Day
Observation Facility, Elevation:	T47,998 ft msl	**Distance from Accident Site:**	9 Nautical Miles
Observation Time:	10:52 Local	**Direction from Accident Site:**	230°
Lowest Cloud Condition:	Few / 1500 ft AGL	**Visibility**	10 miles
Lowest Ceiling:	None	**Visibility (RVR):**	
Wind Speed/Gusts:	9 knots /	**Turbulence Type Forecast/Actual:**	/
Wind Direction:	200°	**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:	29.65 inches Hg	**Temperature/Dew Point:**	23°C / 16°C
Precipitation and Obscuration:			
Departure Point:	Wichita Falls, TX (T47)	**Type of Flight Plan Filed:**	None
Destination:		**Type of Clearance:**	None
Departure Time:	10:05 Local	**Type of Airspace:**	

Airport Information

Airport:	None	**Runway Surface Type:**	
Airport Elevation:		**Runway Surface Condition:**	
Runway Used:		**IFR Approach:**	None
Runway Length/Width:		**VFR Approach/Landing:**	Forced landing

Wreckage and Impact Information

Crew Injuries:	2 Minor	**Aircraft Damage:**	Substantial
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:	N/A	**Aircraft Explosion:**	None
Total Injuries:	2 Minor	**Latitude, Longitude:**	33.856666,-98.487503

Administrative Information

Investigator In Charge (IIC):	Yeager, Leah
Additional Participating Persons:	Mark Wilbourne; FAA/FSDO; Fort Worth, TX Marc Bellheumer; FAA Rotorcraft Certification Office; Fort Worth, TX Gilles Lehoux; Brantly International Inc; Vernon, TX
Original Publish Date:	March 28, 2006
Last Revision Date:	
Investigation Class:	Class
Note:	
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