



National Transportation Safety Board Aviation Accident Final Report

Location:	Goshen, IN	Accident Number:	CEN16LA047
Date & Time:	11/16/2015, 1040 EST	Registration:	N88HA
Aircraft:	EUROCOPTER EC120B	Aircraft Damage:	Substantial
Defining Event:	Sys/Comp malf/fail (non-power)	Injuries:	2 None
Flight Conducted Under:	Part 91: General Aviation - Instructional		

Analysis

The flight instructor and helicopter-rated pilot were returning from an instructional flight in the helicopter. The flight instructor reported they heard a noise come from somewhere in the helicopter. They diverted to a nearby airport for a precautionary landing. As they approached the airport, the noise level increased. The instructor took the controls, and, about 15 ft above ground level and 25 knots, the helicopter began an uncommanded left yaw. The instructor responded with corresponding right pedal input; however, it did not stop the left yaw. The instructor immediately reduced engine power and initiated a hovering autorotation.

A postaccident examination revealed the tail rotor drive system's Thomas coupling interface with the main gear box tail rotor output shaft failed. The Thomas coupling was part of the installation of an after-market air conditioning system approved under a supplemental type certificate (STC). Laboratory examinations revealed that while the pulley within the tail rotor drive system was made to the STC holder's requirements, those requirements deviated significantly from the original equipment output flange. Changes were made to the spline profile, manufacturing method, and lubrication regimen. Any of these changes, either independently or collectively, likely contributed to the increased wear and failure of the Thomas coupling. After the accident, the manufacturer issued a service bulletin and the Federal Aviation Administration issued an emergency airworthiness directive that called for an immediate and repetitive inspection of the coupling every 25 flight hours or deactivating the air conditioning system by removing the STC's Thomas coupling and reinstalling the original equipment manufacturer's Thomas coupling half.

Probable Cause and Findings

The National Transportation Safety Board determines the probable cause(s) of this accident to be:

The failure of the Thomas coupling at the interface with the main gear box tail rotor output shaft, which resulted in the helicopter's loss of tail rotor control.

Findings

Aircraft	Tail rotor drive shaft - Fatigue/wear/corrosion (Cause)
Personnel issues	Modification/alteration - Other/unknown (Factor)

Factual Information

****This report was modified on February 20, 2020. Please see the docket for this accident to view the original report.****

On November 16, 2015, about 1040 eastern standard time, a Eurocopter EC120B helicopter, N88HA, experienced a loss of tail rotor control while on approach for landing at the Goshen Municipal Airport (GSH), Goshen, Indiana. The helicopter-rated pilot and the flight instructor were not injured and the helicopter sustained substantial damage. The helicopter was registered to Hanscopter LLC and operated by the private individual under the provisions of Title 14 *Code of Federal Regulations* Part 91 as an instructional flight. Day visual meteorological conditions prevailed for the flight, which was not operated on a flight plan. The local flight originated from the Elkhart Municipal Airport (EKM) about 1000.

The flight instructor reported they were on a return instructional flight when they heard a noise come from somewhere in the helicopter. The pilot stated it was an "unusual sound." They elected to divert to GSH for a precautionary landing, which was about 3 miles from their current position. The instructor explained that as they approached the airport, the noise level increased. It was at that time that he took the controls. About 15 feet above ground level and 25 knots, the helicopter began an uncommanded left yaw. The instructor added corresponding right pedal, which was not effective in stopping the left yaw. The flight instructor said he immediately reduced engine power and initiated a hovering autorotation.

A postaccident examination revealed the tail rotor drive system's Thomas coupling interface with the main gear box tail rotor output shaft failed. The main gear box tail rotor output shaft transmits torque to the tail rotor via the tail rotor shaft through the Thomas coupling. The Thomas coupling was part of an after-market air conditioning system. A review of maintenance records revealed that the air conditioning system installation was approved under a Federal Aviation Administration (FAA) Supplemental Type Certificate (STC) in 2003; the STC was held by Air Comm Corporation. The STC was installed on the incident helicopter about 150 flight hours prior to the event.

The Air Comm output flange/pulley, Airbus (Eurocopter) output wheel, and Air Comm compressor drive belt from the accident helicopter were sent to the NTSB Materials Laboratory for examination. The pulley and output wheel were examined as part of a group examination with representatives from NTSB, FAA, Airbus Helicopters (the Original Equipment Manufacturer, OEM) and Air Comm Corp. The internal spline on the pulley and external spline on the output wheel exhibited wear of the spline teeth. On the pulley, rust-colored wear debris was observed in the space between the worn teeth. The concentricity of the pulley was examined by measuring the diameter and center location at three positions: the internal diameter forward of the spline, the outer diameter of the body at the aft end of the pulley, and the groove between the second and third pulley ribs. The hardness of the pulley material was measured and found to be in accordance with the hardness requirement for quenched and tempered 4340 steel. The chemical composition of the pulley and output wheel was measured using a portable x-ray fluorescence spectrometer. The reported composition for each component was consistent with each component's respective material specification. A sample

of wear debris from the pulley spline was examined with a scanning electron microscope (SEM) equipped with energy dispersive x-ray spectroscopy (EDS). The detected elements were consistent with a mixture of wear debris from the pulley, wear debris from the output wheel, and molybdenum disulfide dry lubricant.

After the conclusion of the group examination, additional examinations were conducted on the accident pulley, an exemplar pulley from Air Comm, an exemplar output flange from the OEM, and a pulley that was removed from service and returned from the field. The findings from the NTSB Materials Laboratory determined there were four areas of design difference between the OEM Thomas Coupling and Air Comm's Thomas coupling, to include:

1. The production process for the internal spline on the Air Comm Thomas Coupling was different than on the OEM component. The Air Comm process was an Electrical Discharge Machining (EDM) process. This process can produce a rough surface finish. The OEM exemplar output flange exhibited linear tool marks on the internal spline tooth flanks, consistent with a broaching operation.
2. The gapping between the spline teeth of the Air Comm Thomas Coupling and the spline teeth of the OEM's main gear box tail rotor drive shaft at the pitch diameter was found to be greater than that of the OEM's Thomas Coupling half. The measured space width and tooth width values for the exemplar Airbus output flange and output wheel were in accordance with the limits for the fit class. The Air Comm pulley pitch diameter tooth space width exceeded the maximum space.
3. The internal spline profile of the Air Comm Thomas Coupling did not match the involute spline profile of the OEM's main gear box tail rotor drive shaft. By comparison, the tooth flanks of the pulley, with the constant radius form, were not conformal to the tooth flank of the output wheel. Instead, the internal spline teeth made initial contact with the output wheel spline along the edge where the internal spline tooth flank met the internal spline top landing.
4. Examination of the accident pulley and another pulley removed from service revealed different lubricating substances were used. The aircraft maintenance manual of the OEM main gear box tail rotor specified that the output flange spline joint should be lubricated with grease when the flange is installed. The Air Comm pulley installation instructions specified that the pulley internal spline be coated with a jointing compound, Mastinox 8656k or similar.

In response to the accident, the manufacturer published a Service Bulletin (SB-EC120-111815) on November 20, 2015, and the FAA issued an Emergency Airworthiness Directive (Emergency AD 2015-24-51) on November 27, 2015. The SB and EAD called for an immediate and repetitive inspection of the coupling every 25 flight-hours or deactivating the air conditioning system by removing the STC's Thomas coupling and re-installing the original equipment manufacturers (OEM) Thomas coupling half. Installing the OEM would return the tail rotor shaft drive system to its original design. On May 8, 2017, the Emergency AD was superseded by FAA Airworthiness Directive 2017-06-11 that revised the applicability, some of the terminology, and the inspection requirements of the Emergency AD.

History of Flight

Enroute-cruise	Sys/Comp malf/fail (non-power) (Defining event) Loss of tail rotor effectiveness
Autorotation	Off-field or emergency landing

Pilot Information

Certificate:	Airline Transport; Commercial	Age:	60, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	Seat Occupied:	Right
Other Aircraft Rating(s):	Helicopter	Restraint Used:	
Instrument Rating(s):	Airplane	Second Pilot Present:	Yes
Instructor Rating(s):	None	Toxicology Performed:	No
Medical Certification:	Class 2 With Waivers/Limitations	Last FAA Medical Exam:	10/09/2015
Occupational Pilot:	No	Last Flight Review or Equivalent:	10/28/2015
Flight Time:	5100 hours (Total, all aircraft), 112 hours (Total, this make and model)		

Flight Instructor Information

Certificate:	Airline Transport; Flight Instructor; Commercial	Age:	54, Male
Airplane Rating(s):	Multi-engine Land; Single-engine Land	Seat Occupied:	Left
Other Aircraft Rating(s):	Helicopter	Restraint Used:	
Instrument Rating(s):	Airplane; Helicopter	Second Pilot Present:	Yes
Instructor Rating(s):	Helicopter	Toxicology Performed:	No
Medical Certification:	Class 2 With Waivers/Limitations	Last FAA Medical Exam:	02/10/2015
Occupational Pilot:	Yes	Last Flight Review or Equivalent:	10/30/2015
Flight Time:	11200 hours (Total, all aircraft), 750 hours (Total, this make and model)		

Aircraft and Owner/Operator Information

Aircraft Make:	EUROCOPTER	Registration:	N88HA
Model/Series:	EC120B B	Aircraft Category:	Helicopter
Year of Manufacture:	2010	Amateur Built:	No
Airworthiness Certificate:	Normal	Serial Number:	1634
Landing Gear Type:	Skid	Seats:	5
Date/Type of Last Inspection:	05/06/2015, Annual	Certified Max Gross Wt.:	6561 lbs
Time Since Last Inspection:		Engines:	1 Turbo Shaft
Airframe Total Time:	320 Hours at time of accident	Engine Manufacturer:	Arrius
ELT:	C126 installed, not activated	Engine Model/Series:	2F
Registered Owner:	HANSCOPTER LLC	Rated Power:	504 hp
Operator:	HANSCOPTER LLC	Operating Certificate(s) Held:	None

Meteorological Information and Flight Plan

Conditions at Accident Site:	Visual Conditions	Condition of Light:	Day
Observation Facility, Elevation:	GSH, 827 ft msl	Distance from Accident Site:	0 Nautical Miles
Observation Time:	1053 EST	Direction from Accident Site:	360°
Lowest Cloud Condition:	Clear	Visibility	10 Miles
Lowest Ceiling:	None	Visibility (RVR):	
Wind Speed/Gusts:	8 knots /	Turbulence Type Forecast/Actual:	/
Wind Direction:	160°	Turbulence Severity Forecast/Actual:	/
Altimeter Setting:	30.23 inches Hg	Temperature/Dew Point:	12° C / 1° C
Precipitation and Obscuration:	No Obscuration; No Precipitation		
Departure Point:	Elkhart, IN (EKM)	Type of Flight Plan Filed:	None
Destination:	Elkhart, IN (EKM)	Type of Clearance:	None
Departure Time:	1000 EST	Type of Airspace:	Class E

Airport Information

Airport:	Goshen Municipal (GSH)	Runway Surface Type:	Grass/turf
Airport Elevation:	827 ft	Runway Surface Condition:	Dry
Runway Used:	N/A	IFR Approach:	None
Runway Length/Width:		VFR Approach/Landing:	Forced Landing; Precautionary Landing

Wreckage and Impact Information

Crew Injuries:	2 None	Aircraft Damage:	Substantial
Passenger Injuries:	N/A	Aircraft Fire:	None
Ground Injuries:	N/A	Aircraft Explosion:	None
Total Injuries:	2 None	Latitude, Longitude:	41.526667, -85.793333

Administrative Information

Investigator In Charge (IIC):	Courtney Liedler	Report Date:	04/13/2020
Additional Participating Persons:	Matthew Rigsby; FAA Accident Investigation Division; Washington, DC Richard R Thomas; FAA; Denver, CO Matthew Bryant; FAA; Denver, CO Keith D Pharris; Air Comm; Westminster, CO Emanuele Figlia; Airbus Helicopters; Grand Prairie, TX		
Publish Date:	04/13/2020		
Note:	The NTSB did not travel to the scene of this accident.		
Investigation Docket:	http://dms.nts.gov/pubdms/search/dockList.cfm?mKey=92349		

The National Transportation Safety Board (NTSB), established in 1967, is an independent federal agency mandated by Congress through the Independent Safety Board Act of 1974 to investigate transportation accidents, determine the probable causes of the accidents, issue safety recommendations, study transportation safety issues, and evaluate the safety effectiveness of government agencies involved in transportation. The NTSB makes public its actions and decisions through accident reports, safety studies, special investigation reports, safety recommendations, and statistical reviews.

The Independent Safety Board Act, as codified at 49 U.S.C. Section 1154(b), precludes the admission into evidence or use of any part of an NTSB report related to an incident or accident in a civil action for damages resulting from a matter mentioned in the report. A factual report that may be admissible under 49 U.S.C. § 1154(b) is available [here](#).