Aviation Investigation Final Report

Location:	Linden, New Jersey	**Incident Number:**	ENG23LA045
Date & Time:	September 21, 2023, 08:00 Local	**Registration:**	N406TD
Aircraft:	Bell 407	**Aircraft Damage:**	None
Defining Event:	Unknown or undetermined	**Injuries:**	
Flight Conducted Under:	Unknown		

Analysis

The upper-left tail boom attachment bolt failed due to fatigue fracture and subsequent overload. Fatigue cracking initiated on the upper-left tail boom attachment bolt due to abnormal loading of the bolt shank caused by the presence of a gap and misalignment between the aft fuselage upper-left longeron and the tail boom. The gap and misalignment were likely introduced during installation of a new upper-left longeron in 2014, about 3,858.9 flight hours prior to discovery of the fractured upper-left attachment bolt. After the upper-left attachment bolt fractured, the load normally carried by the upper-left attachment fitting was redistributed to the remaining three tail boom attachment fittings. As a result, multiple-origin fatigue cracking initiated on the lower-left longeron fitting.

This incident was the third known occurrence involving a fractured upper-left tail boom attachment bolt due to a gap and misalignment of the upper-left longeron. (In NTSB investigation ANC22FA041, one of the three occurrences, the upper-left tail boom attachment bolt was not found, but the upper-left tail boom attachment bolt likely fractured based on the available information.) In the three occurrences, each involving a different repair facility, the upper-left longeron was installed in accordance with Bell Technical Bulletin (TB) 407-12-96. Bell TB 407-12-96 did not contain steps to verify the absence of gaps and misalignment between the upper-left longeron and the aft fuselage bulkhead at the end of their installation instructions. The lack of these verification steps was a factor in the nondetection of the gap and misalignment that were introduced during the upper-left longeron installation for these three occurrences.

On June 8, 2022, a Bell 407 helicopter, N402SH, experienced an inflight separation of its tail boom (NTSB investigation ANC22FA041). During the N402SH investigation, the NTSB issued safety recommendations A-22-29 and A-22-31 to the Federal Aviation Administration (FAA)

and Transport Canada Civil Aviation (TCCA), respectively, to require subsequent torque checks of the tail boom attachment hardware be performed at a more stringent interval until the causal factors of the N402SH accident could be determined and corrective actions enacted. The FAA and TCCA did not take the recommended action and the tail boom attachment hardware torque check interval remained unchanged at 300-hours. As a result, the incident operator did not discover the fractured upper-left attachment bolt until a scheduled 300-hour inspection, by which time a fatigue crack on the lower-left tail boom attachment fitting had already initiated and grew. The combination of a loss of the upper-left tail boom attachment load path and fatigue crack growth on the lower-left longeron fitting substantially increased the risk of an inflight tail boom separation. Had the FAA and TCCA adopted the NTSB's previously recommended action, the operator of this incident would have had more opportunities to detect the fractured upper-left attachment bolt, mitigating the risk of an inflight tail boom separation.

Probable Cause and Findings

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

The fracture of the upper-left tail boom attachment bolt due to abnormal loading of the bolt caused by a gap and misalignment between the upper-left longeron and the tail boom. Contributing to this incident was the lack of a check to verify the absence of gaps or misalignments at the conclusion of installation for the upper-left longeron.

Findings

Aircraft	Longerons/stringers (main fus) - Incorrect service/maintenance
Aircraft	Longerons/stringers (main fus) - Related maintenance info
Aircraft	Longerons/stringers (main fus) - Damaged/degraded

Factual Information

History of Flight

Other	Aircraft maintenance event
Unknown	Unknown or undetermined (Defining event)
Other	Aircraft inspection event

On September 21, 2023, the operator of a Bell 407 helicopter, N406TD, found a fractured upper-left tail boom attachment bolt during scheduled inspections that included a torque check of the four tail boom attachment bolts (Figure 1). Subsequent inspection of the aft fuselage structure by the incident operator, Helicopter Flying Services, doing business as HeliNY, found the lower-left tail boom attachment fitting exhibited a crack emanating from its bolt hole (Figure 2). After discovery of the fractured bolt and removal of the tail boom, the operator determined the upper-left longeron fitting was not in plane with the remaining three fuselage-side tail boom attachment fittings. The misaligned upper-left attachment fitting resulted in a gap that was at most about 0.015 inches at its outboard side (Figure 3). Additionally, a notable quantity of corrosion preventive compound (CPC) was found on the contact surfaces of the upper-left tail boom attachment point, whereas the remaining three tail boom attachment points did not have CPC on their contact surfaces (Figure 4). On January 12, 2024, Transport Canada Civil Aviation (TCCA) informed the National Transportation Safety Board (NTSB) of this occurrence, after which the NTSB opened an incident investigation.

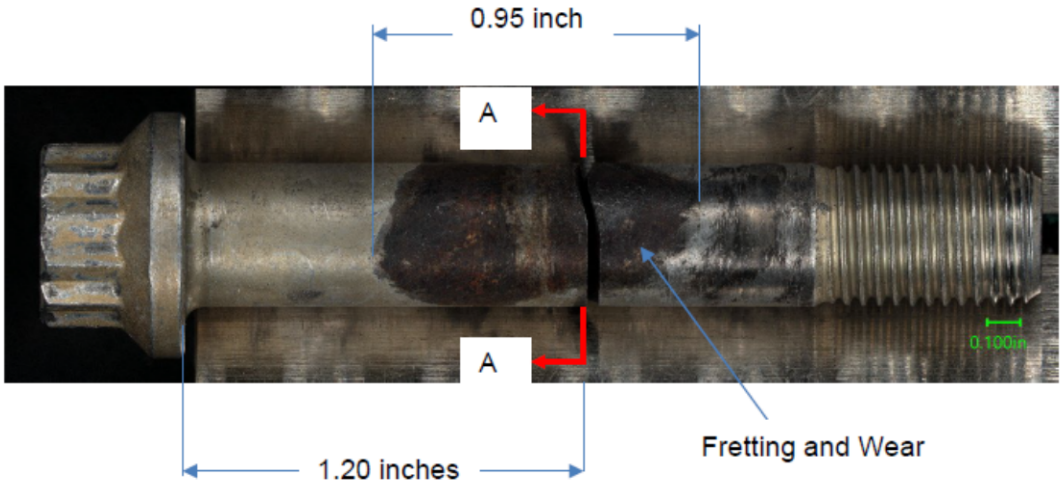

Figure 1. The fractured upper-left tail boom attachment bolt. See Figure 5 of this report for a view of Section A-A in this image. (Image courtesy of Bell)

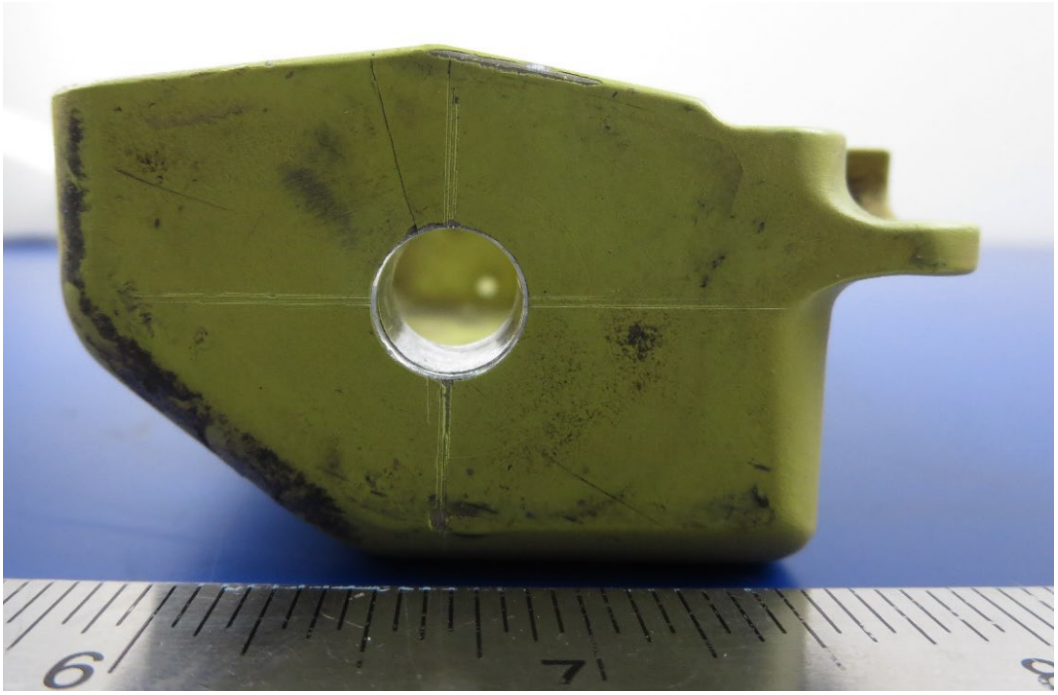

Figure 2. The crack discovered on the lower-left tail boom attachment fitting. (Image courtesy of Bell)

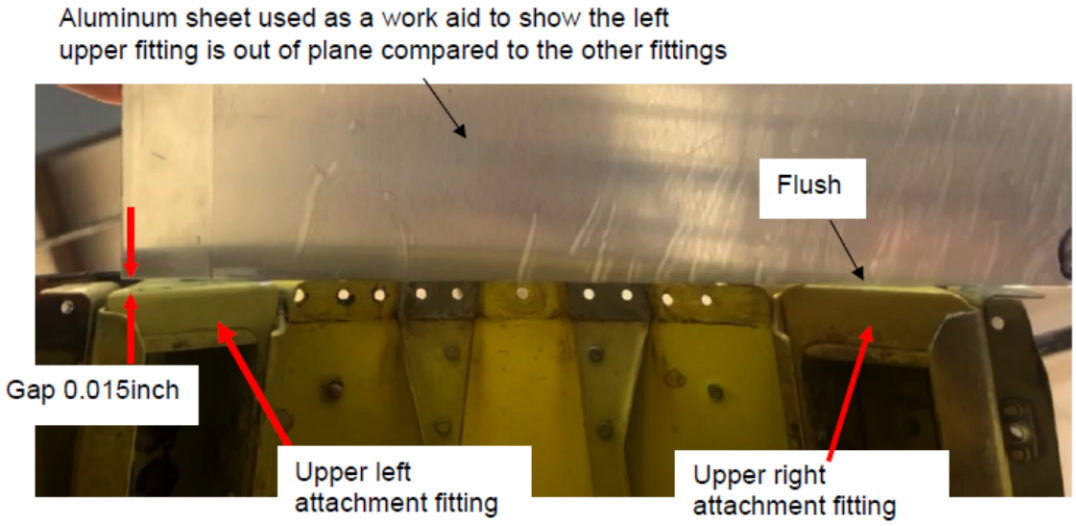

Figure 3. The misalignment observed on the upper-left tail boom attachment fitting, bottom-looking-up. (Image courtesy of Bell)

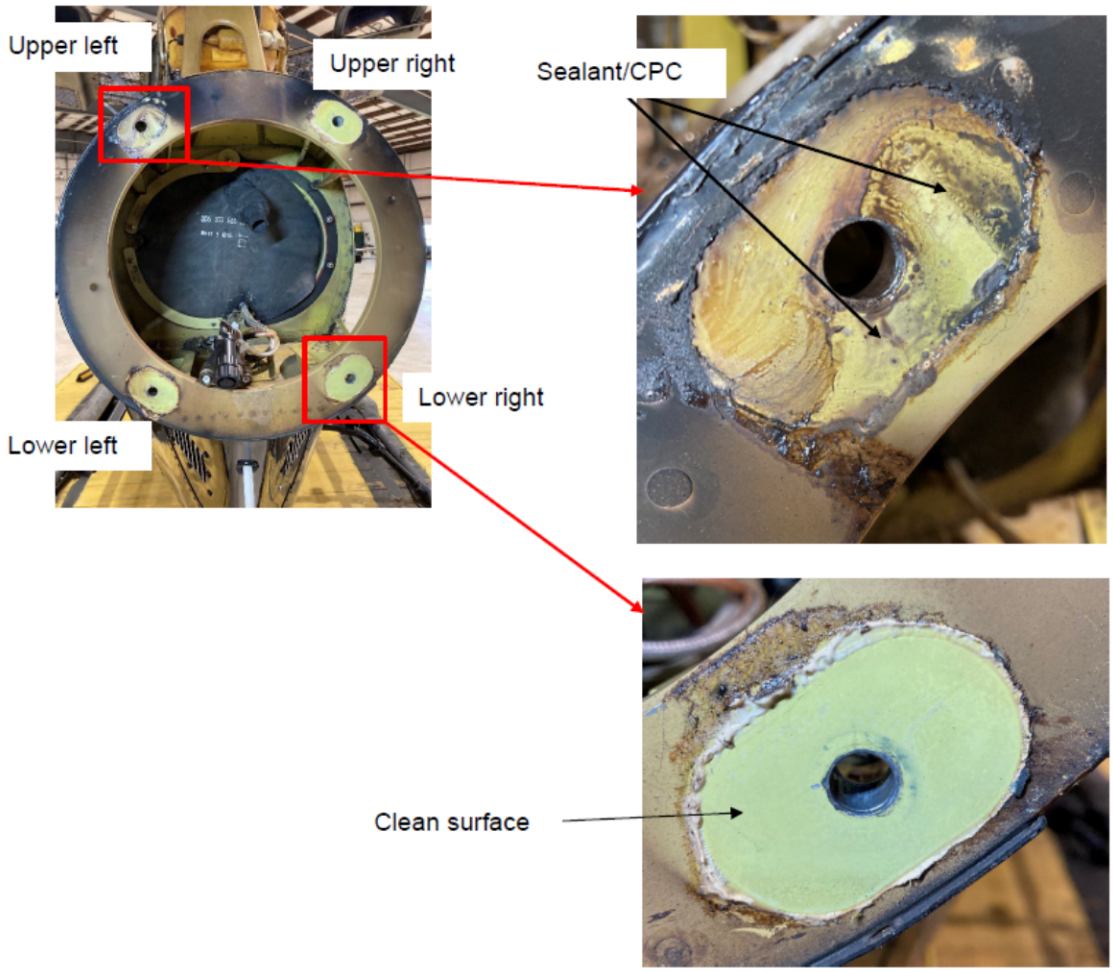

Figure 4. The tail boom attachment surfaces of the aft fuselage bulkhead, aft-looking-forward. (Image courtesy of Bell)

In November 2023, Bell requested the operator ship the upper-left longeron. The operator subsequently shipped the upper-left bolt, the upper-left longeron, and the lower-left longeron to the Bell Field Investigations Lab in Hurst, Texas for detailed examination. For the upper-left attachment bolt, the fracture was located on the bolt shank, about 1.20 inches below the underside of the bolt head. An area of fretting and wear was visible on the bolt shank and was co-located with the fracture. The bolt fracture face exhibited fatigue cracking emanating from multiple origins (Figure 5). Fatigue cracking grew about 0.37 inches across the fracture face until it transitioned to overload. Corrosion damage on the upper-left attachment bolt fracture surface precluded both striation and band counting to estimate the duration of fatigue growth. Examination of the crack on the lower-left longeron fitting found evidence of fatigue emanating from multiple origins from a 0.0002-inch deep machining line (Figure 6). Band counting of the lower-left longeron crack surface counted about 149 bands, with higher concentrations of

bands observed near the area of the crack origin. Both the upper-left attachment bolt and the lower-left longeron fitting materials and dimensions conformed to drawing requirements.

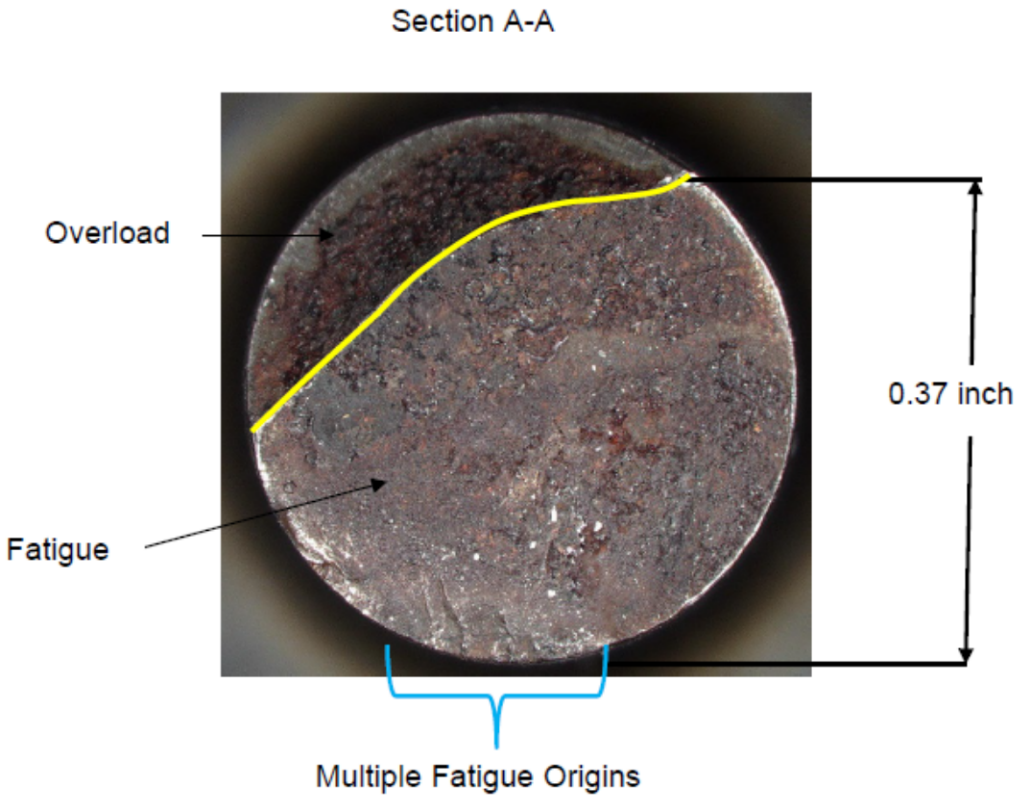

Figure 5. The fracture surface of the upper-left attachment bolt. (Image courtesy of Bell)

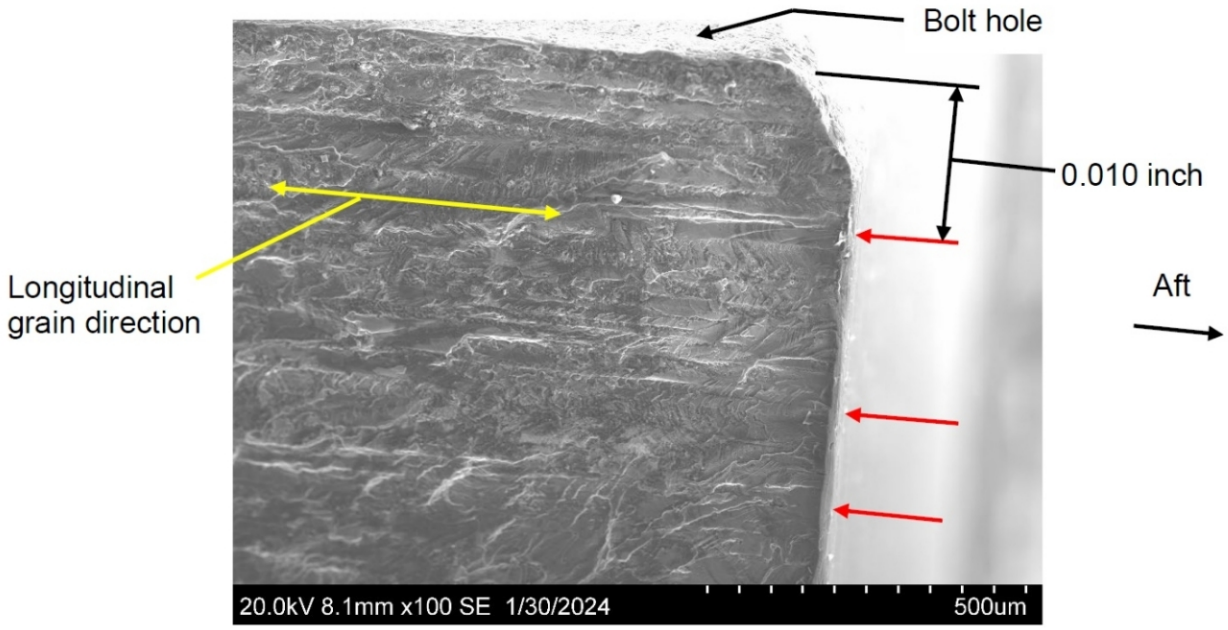

Figure 6. A close-up of the fatigue origins (red arrows) in a 0.0002-inch deep machining line on the lower-left longeron fitting. Crack growth was in the longitudinal grain direction. (Image courtesy of Bell)

The incident helicopter was manufactured in 2007 with airframe serial number (S/N) 53745. The incident helicopter was involved in an accident on May 30, 2013, registered as N407HC at that time. For further information on the prior accident, reference NTSB investigation ERA13TA261. The helicopter landed hard during that accident. The postaccident repairs were accomplished at Summit Aviation in Middletown, Delaware under work order No. MR4387, to bring the helicopter back to service. During these repairs, the fuselage was disassembled and transported to USCAN Limited in Ontario, Canada for structural repairs under work order No. 7574. These structural repairs included replacement of the aft fuselage upper-left, lower-left, and lower-right longerons. The new upper-left longeron, part number (P/N) 206-031-314-237B, was installed in accordance with Bell Technical Bulletin (TB) No. 407-12-96 Revision A. The aft fuselage bulkhead that was removed in September 2023 was stamped as being manufactured in May 18, 2006, and was therefore likely original to the manufacture of the incident helicopter. The postaccident repairs were completed on December 5, 2014 at an ATT of 1,929.6 hours. According to HeliNY, based on the available helicopter records, the tail boom had not been removed since its installation after repairs were completed at Summit Aviation. Therefore, the tail boom attachment bolts had accumulated about 3,858.9 hours from their installation in 2014 to the time the upper-left attachment bolt was discovered fractured in 2023.

NTSB investigation ANC22FA041, involving an inflight tail boom separation on a Bell 407, N402SH, found two occurrences, including the N402SH accident, during which the upper-left tail boom attachment load path was lost due to a fractured upper-left tail boom attachment bolt. Additionally, the loss of the upper-left tail boom attachment load path resulted in fatigue cracking of the lower-left tail boom attachment fitting. Once fatigue cracking of the lower-left tail boom attachment fitting had sufficient time to grow, the lower-left tail boom attachment fitting, along with the upper-right and lower-right tail boom attachment fittings, would fail in overload, resulting in a tail boom separation. In the N402SH accident, the last torque check of the tail boom attachment bolts was accomplished about 114 hours prior to the inflight separation of the tail boom, with no noted anomalies during that torque check. On December 1, 2022, based on the evolving findings from NTSB investigation ANC22FA041, the NTSB issued Safety Recommendation Nos. A-22-28 through A-22-31 to the Federal Aviation Administration (FAA) and TCCA to conduct torque checks of the tail boom attachment hardware and visual inspection of the tail boom attachment fittings, both immediately and at an interval significantly less than the required 300-hour interval. On December 8, 2022, Bell issued Alert Service Bulletin (ASB) No. 407-22-128 for a one-time torque check and visual inspection of the tail boom attachment hardware and fittings, respectively. Subsequently, TCCA and the FAA issued Airworthiness Directive (AD) No. CF-2022-68 and No. 2022-27-08, respectively, to require the actions of Bell ASB No. 407-22-128. At the time of the N406TD incident, neither TCCA nor the FAA acted upon NTSB safety recommendation Nos. A-22-29 and A-22-31, which recommended TCCA and FAA require subsequent torque checks of the tail boom attachment hardware and inspection of the tail boom attachment fittings at an interval significantly less than the required 300-hour interval.

According to the maintenance records for N406TD, the incident operator accomplished Bell ASB No. 407-22-128 on December 16, 2022 at an aircraft total time (ATT) of 4,867.9 hours. No anomalous findings were noted during accomplishment of ASB No. 407-22-128. After the one-time inspection per Bell ASB No. 407-22-128, the incident operator continued to conduct recurrent torque checks of the tail boom attachment bolts at the required 300-hour interval. A total of three 300-hour torque checks were completed, with no anomalous findings, between accomplishment of ASB No. 407-22-128 and the discovery of the fractured upper-left attachment bolt. These torque checks occurred on 1) March 16, 2023 at an ATT of 4,997.9 hours; 2) May 23, 2023 at an ATT of 5,213.9 hours; and 3) July 27, 2023 at an ATT of 5,506.2 hours. The fractured upper-left attachment bolt was found during the fourth scheduled 300-hour torque check on September 21, 2023 at an ATT of 5,788.5 hours.

On February 12, 2024, Bell issued ASB No. 407-24-134, a three-part ASB intended as an interim action until a future revision of the ASB would include terminating actions to the ASB's recurrent inspections. Part I of the ASB requires determination of whether the upper-left

longeron was original to the manufacture of the helicopter or if it had been replaced in accordance with TB 407-12-96 or TB 407-17-125. If the upper-left longeron had been replaced in accordance with the aforementioned TBs, Part II of the ASB applied and required a 300-hour recurrent inspection of the tail boom attachment structure that included removal and replacement of the upper-left attachment bolt [every 300-hours] as well as a torque check of the remaining three tail boom attachment bolts. If the upper-left longeron was original to the manufacture of the helicopter, Part III of the ASB applied and required a 50-hour recurrent inspection of the tail boom attachment structure that included a torque check of the four tail boom attachment bolts. At the time of this report, neither the FAA nor TCCA has mandated the actions of Bell ASB No. 407-24-134. Bell issued Revision A to TB 407-17-125, dated April 4, 2024, and Revision B to TB 407-07-78, dated April 9, 2024, that included clarifications and additional instructions to verify the in-plane condition of the aft fuselage longeron. Bell issued Revision B to TB 407-12-96, dated May 1, 2024, in which the subject TB was superseded by TB 407-17-125.

Information

Certificate:	**Age:**
Airplane Rating(s):	**Seat Occupied:**
Other Aircraft Rating(s):	**Restraint Used:**
Instrument Rating(s):	**Second Pilot Present:**
Instructor Rating(s):	**Toxicology Performed:**
Medical Certification:	**Last FAA Medical Exam:**
Occupational Pilot:	**Last Flight Review or Equivalent:**
Flight Time:	

Aircraft and Owner/Operator Information

Aircraft Make:	Bell	**Registration:**	N406TD
Model/Series:	407	**Aircraft Category:**	Helicopter
Year of Manufacture:	2006	**Amateur Built:**	
Airworthiness Certificate:	Normal	**Serial Number:**	53745
Landing Gear Type:	Skid	**Seats:**	
Date/Type of Last Inspection:		**Certified Max Gross Wt.:**	
Time Since Last Inspection:		**Engines:**	
Airframe Total Time:		**Engine Manufacturer:**	
ELT:		**Engine Model/Series:**	
Registered Owner:	HELICOPTER TRANSPORT LLC	**Rated Power:**	
Operator:	Helicopter Flight Services Inc.	**Operating Certificate(s) Held:**	On-demand air taxi (135)
Operator Does Business As:	HeliNY	**Operator Designator Code:**	

Meteorological Information and Flight Plan

Conditions at Accident Site:	Unknown	**Condition of Light:**	Not reported
Observation Facility, Elevation:		**Distance from Accident Site:**	
Observation Time:		**Direction from Accident Site:**	
Lowest Cloud Condition:		**Visibility**	
Lowest Ceiling:		**Visibility (RVR):**	
Wind Speed/Gusts:	/	**Turbulence Type Forecast/Actual:**	/
Wind Direction:		**Turbulence Severity Forecast/Actual:**	/
Altimeter Setting:		**Temperature/Dew Point:**	
Precipitation and Obscuration:			
Departure Point:		**Type of Flight Plan Filed:**	
Destination:		**Type of Clearance:**	None
Departure Time:		**Type of Airspace:**	

Wreckage and Impact Information

Crew Injuries:	N/A	**Aircraft Damage:**	None
Passenger Injuries:		**Aircraft Fire:**	None
Ground Injuries:		**Aircraft Explosion:**	None
Total Injuries:	N/A	**Latitude, Longitude:**	40.616379,-74.242562(est)

Administrative Information

Investigator In Charge (IIC):	Shin, Chihoon
Additional Participating Persons:	David Keenan; Federal Aviation Administration; Washington, DC Michael Dillon; Helicopter Flight Services; Linden, NJ Helen Tsai; Transportation Safety Board of Canada Gary Howe; Bell; Hurst, TX Darrell Smith; Summit Aviation Dean Ciaschini; Transport Canada Civil Aviation
Original Publish Date:	June 28, 2024
Last Revision Date:	
Investigation Class:	Class 3
Note:	The NTSB did not travel to the scene of this incident.
Investigation Docket:	https://data.ntsb.gov/Docket?ProjectID=193675