

December 1, 2022

Aviation Investigation Report AIR-22-10

Require Immediate Inspection of Bell 407 Tail Boom Attachment Hardware and Fittings

Introduction

The National Transportation Safety Board (NTSB) is providing the following information to urge the Federal Aviation Administration (FAA) and Transport Canada to take immediate action on the safety recommendations in this report. We identified this issue during our ongoing investigation of the June 8, 2022, accident involving a Bell 407 helicopter, N402SH, which experienced an inflight separation of its tail boom during cruise flight near Kalea, Hawaii. The NTSB is issuing two urgent safety recommendations each to the FAA and Transport Canada.¹

Background and Analysis

On June 8, 2022, about 1726 Hawaii-Aleutian standard time, a Bell 407 helicopter, N402SH, impacted terrain near Kalea, Hawaii, following an inflight separation of the tail boom. The pilot and two passengers sustained serious injuries, and three passengers sustained minor injuries. The helicopter sustained substantial damage during the impact. The on-demand air tour flight was operated by Paradise Helicopters under Title 14 *Code of Federal Regulations* Part 135.²

According to the pilot, about 30 minutes into the flight, the helicopter began an uncontrolled spin to the right. A passenger reported that, as the helicopter continued to spin, she observed something fall off the helicopter; however, she was not able to identify a specific part. The helicopter continued to spin uncontrollably while it descended and impacted an area of rough, uneven, lava-covered terrain.

The examination of the accident site revealed the tail boom came to rest about 762 ft northeast from the main wreckage, consistent with an inflight separation. Examination of the tail boom revealed it separated from the fuselage at the tail boom

¹ The recommendations are issued to both the FAA and Transport Canada because the FAA is the regulator for US operators and Transport Canada is the regulator for the state of design and manufacture of the helicopter. Both agencies have the authority to mandate such actions.

² Visit [ntsb.gov](https://www.ntsb.gov) to find additional information in the [public docket](#) for this ongoing NTSB investigation (case no. [ANC22FA041](#)). Use the [CAROL Query](#) to search safety recommendations and investigations.

attach point. Figure 1 shows the location of separation and the attachment fittings and hardware used to secure the tail boom to the fuselage.

The upper-left tail boom attachment hardware, consisting of a bolt, washers, and a nut, was not present at the accident site and was not found. The attachment fitting remained connected to the fuselage. Damage to the upper-left attachment bolt holes indicates the bolt had been installed at some point before the accident flight; it is unknown at this time when or why the bolt separated. Additionally, the lower-left, lower-right, and upper-right tail boom attachment fittings (connecting the tail boom to the aft fuselage) were fractured and found, along with their attachment hardware, with the tail boom wreckage. The lower-left fitting had multiple fatigue fractures, while the upper-right and lower-right attachment fittings had overload fractures. The initiation of fatigue cracks on the lower-left fitting indicates that the tail boom did not immediately separate from the helicopter upon the separation of the upper-left attachment hardware.

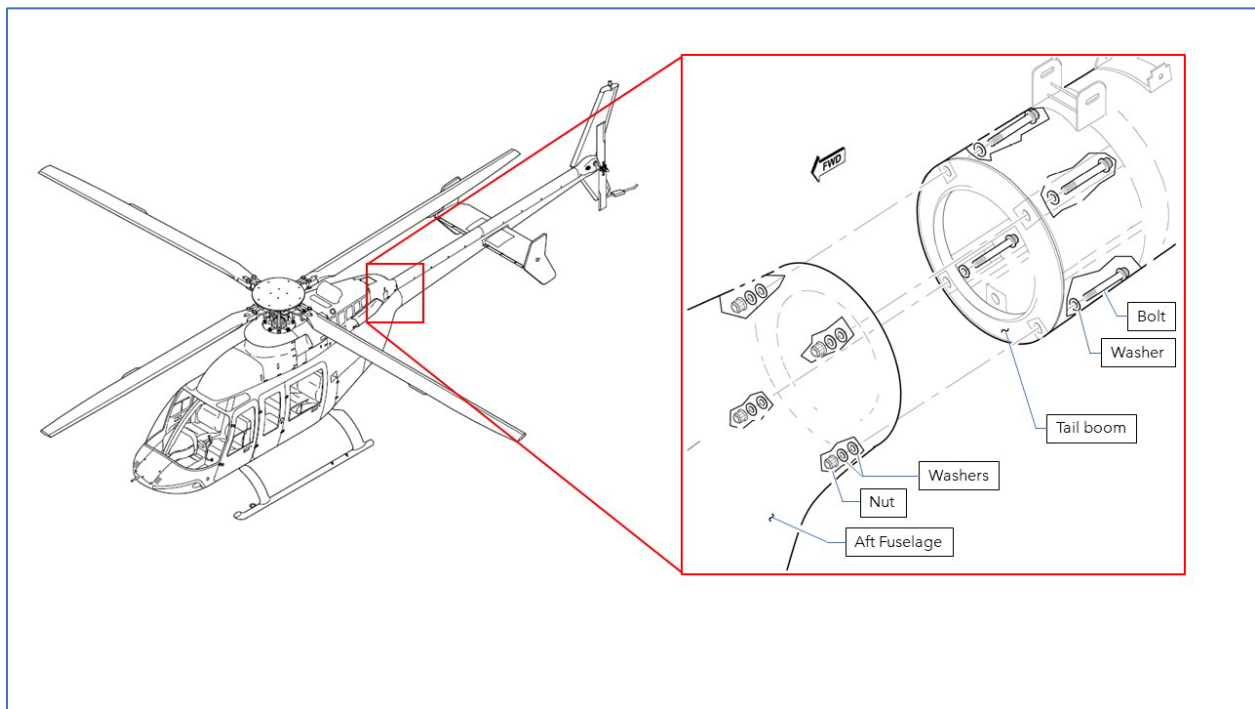


Figure 1. Location of tail boom attach point and hardware used (Source: Bell and edited by NTSB). Attachment hardware consists of a bolt, washers, and a nut.

Figure 2 shows the accident helicopter tail boom with the fractured remnants of the upper-right, lower-left, and lower-right attachment fittings and their respective attachment hardware. Figure 3 shows the upper-left tail boom attachment fitting found with the main fuselage wreckage.

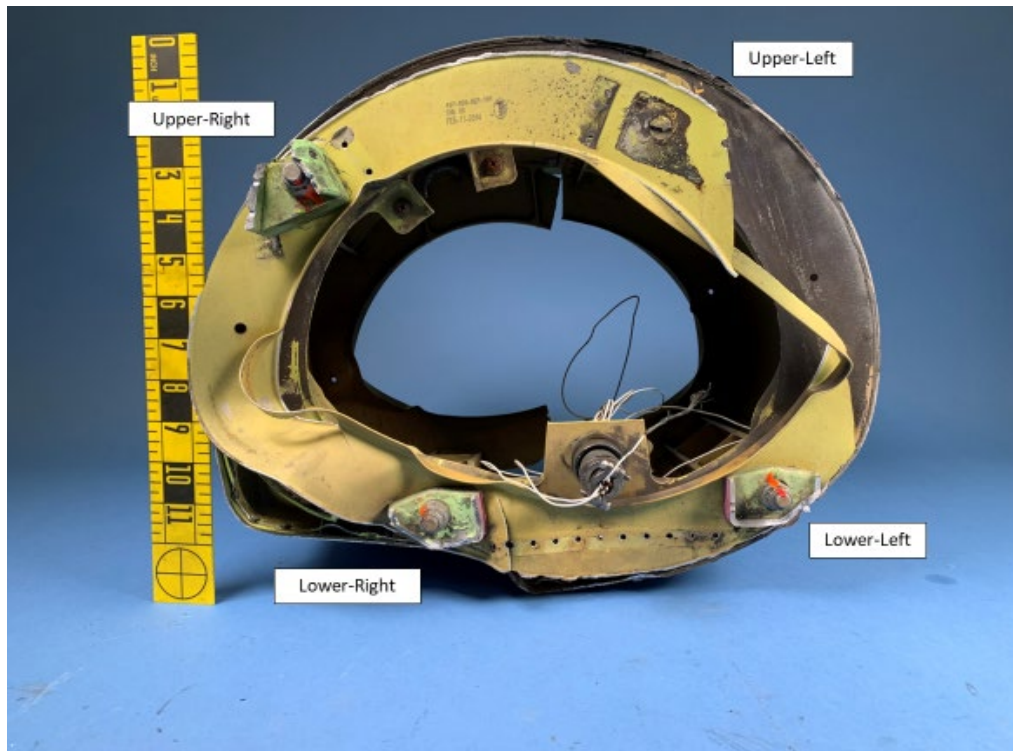


Figure 2. Tail boom with fractured remains of attachment fittings and hardware. Upper-left attachment hardware (bolt, washers, and nut) was not present. The lower left, lower right, and upper right attachment hardware (bolt, washers, and nut) remained installed.

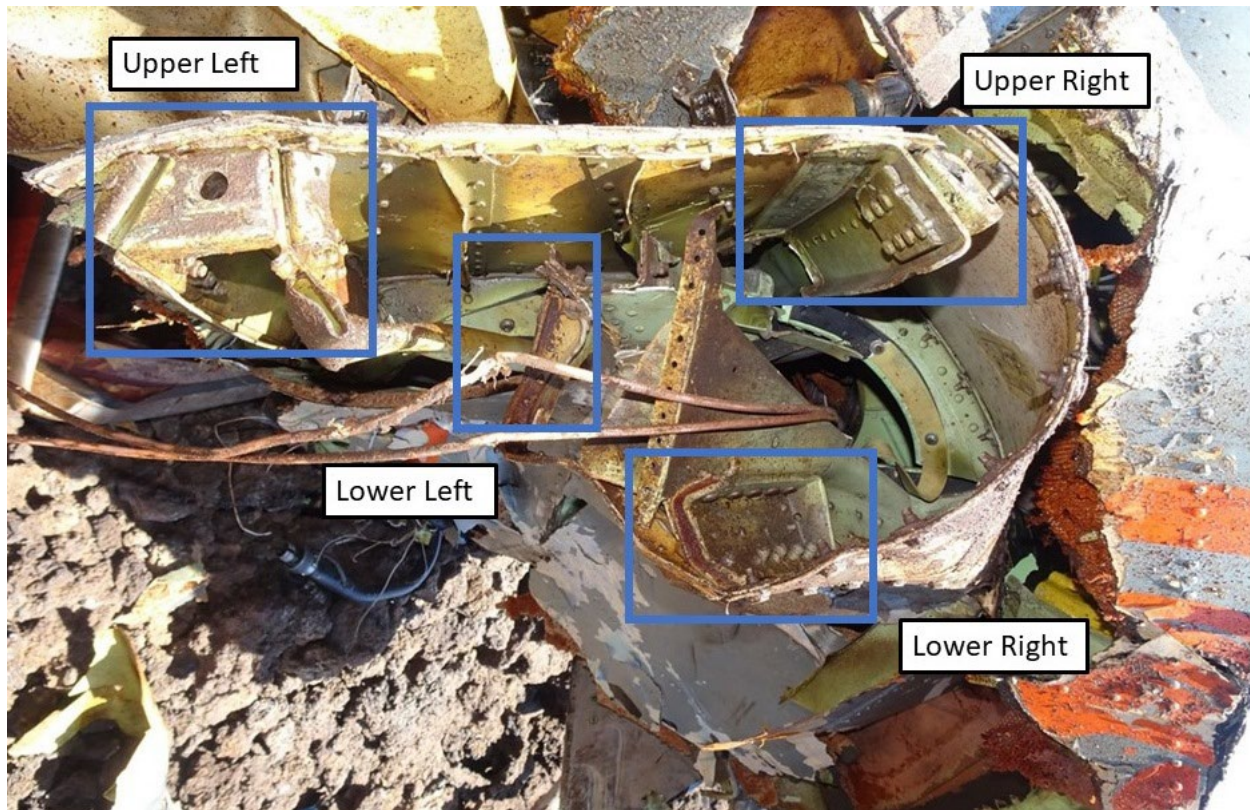


Figure 3. Aft fuselage with upper-left tail boom attachment fitting.

According to Bell (the helicopter manufacturer), the upper-left tail boom attachment fitting has the highest tension loading of the four attachment fittings and is considered the most important of the four attachment fittings between the tail boom and the aft fuselage. The upper-left tail boom attachment bolt separated first, resulting in the redistribution of the load normally carried by the upper-left attachment fitting to the remaining three attachment fittings and the subsequent initiation of fatigue fractures on the lower-left attachment fitting. Based on preliminary analysis of the fatigue crack growth on the lower-left attachment fitting, it is possible that the fatigue crack grew over multiple takeoffs and landings. However, this analysis is ongoing, and the results of the analysis, once completed, will be shared with the FAA and the Transportation Safety Board of Canada.

The Bell 407 maintenance manual requires a torque check of the tail boom attachment hardware and a visual inspection of the tail boom attachment fittings every 300 hours.³ A review of the accident helicopter's maintenance records revealed that the most recent tail boom attachment hardware torque check and visual inspection of the attachment fittings was completed 114.2 hours before the accident

³ A torque check involves checking the tightness of the hardware, as installed, to ensure it continues to retain the required torque. Hardware that has not retained torque typically requires disassembly and inspection or replacement.

occurred with no anomalies noted during the visual inspection and no noted loss of torque of the attachment hardware (attachment hardware that is not installed properly, is cracked and/or is near an impending failure could exhibit a loss of installation torque and not pass a torque check). Furthermore, no additional maintenance had been conducted to the attachment hardware since the last torque check.

Our investigation into this accident is ongoing. However, given the findings thus far during the investigation, we are concerned that there may be additional Bell 407 helicopters with missing or fractured tail boom attachment hardware, and the potential for catastrophic failure warrants immediate and mandatory action. The NTSB concludes that any tail boom attachment hardware or fittings that is not installed properly or is fractured is a safety hazard because it can result in an inflight separation of the tail boom, which is catastrophic. Therefore, the NTSB recommends that the FAA and Transport Canada require operators of Bell 407 helicopters to conduct an immediate torque check of the tail boom attachment hardware, as well as a visual inspection of the tail boom attachment fittings for evidence of cracks and fractures, and report findings to their respective regulatory authority.

Our investigation has not yet determined why the upper-left tail boom attachment hardware separated on the accident helicopter. Because the tail boom separated only 114.2 hours after its last torque check and visual inspection, the NTSB is also concerned that instances of improperly installed or fractured attachment hardware or fittings may not be detected within the existing 300-hour recurrent torque check and visual inspection interval and that an in-flight separation of the tail boom could occur on other Bell 407 helicopters.

The separation of the upper-left attachment bolt may not result in an immediate separation of the tail boom but represents an impending catastrophic failure. For the accident helicopter, a shorter torque check and visual inspection interval of the tail boom attachment hardware and fittings, respectively, would have increased the number of opportunities to detect that the upper-left attachment hardware had separated or fractured and the resultant fatigue cracking of the lower-left attachment fitting on the accident helicopter before an inflight separation of the tail boom could occur. The NTSB believes that a shorter torque check and visual inspection interval for all Bell 407 helicopters would increase the likelihood of detecting fractured attachment hardware before a catastrophic failure can occur, and any reported findings from these torque checks and visual inspections can help in understanding when and why the tail boom attachment hardware may separate.

Until the causal factors that led to the separation of the upper-left attachment hardware can be determined and measures are enacted to ensure the continued integrity of the attachment hardware, the NTSB concludes that, as an interim action, a considerably more conservative torque check and visual inspection interval that is

less than 300 hours is warranted to identify any improperly installed or fractured tail boom attachment hardware or fittings to avoid potential separation of the tail boom.

Therefore, the NTSB recommends that the FAA and Transport Canada require operators of Bell 407 helicopters to conduct subsequent torque checks of the tail boom attachment hardware and visual inspection of the tail boom attachment fittings as referenced in Safety Recommendations A-22-28 and -30 at an interval significantly less than the currently required interval to provide multiple opportunities for detecting any improperly installed or fractured attachment hardware or fittings. Require operators to report findings to their respective regulatory authority.

The NTSB notes that determining a more conservative interval for the torque check and visual inspection can be challenging given the limited information available. The time since the last torque check of the accident helicopter (114.2 hours), as well as additional information from the initial torque check and inspection as recommended, could help the regulatory authorities establish an intermediate torque check and visual inspection interval that will provide multiple opportunities to detect potential failures. The data that are collected during the subsequent torque checks of the tail boom attachment hardware and visual inspections of the tail boom attachment fittings can then help regulatory authorities determine factors that could lead to the separation of tail boom attachment hardware and establish the appropriate torque check and visual inspection interval to detect potential fractured tail boom attachment hardware in the future.

The NTSB notes that the need for these actions is based on preliminary findings during our ongoing investigation. Additional actions may be recommended as the investigation proceeds.

Findings

Any tail boom attachment hardware or fittings that is not installed properly or is fractured is a safety hazard because it can result in an inflight separation of the tail boom, which is catastrophic.

A considerably more conservative torque check and visual inspection interval that is less than 300 hours is warranted to identify any improperly installed or fractured tail boom attachment hardware or fittings to avoid potential separation of the tail boom.

Recommendations

To the Federal Aviation Administration:

Require operators of Bell 407 helicopters to conduct an immediate torque check of the tail boom attachment hardware, as well as a visual inspection of the tail boom attachment fittings for evidence of cracks and fractures, and report findings to the FAA. (A-22-28) (Urgent)

Require operators of Bell 407 helicopters to conduct subsequent torque checks of the tail boom attachment hardware and visual inspection of the tail boom attachment fittings as referenced in Safety Recommendation A-22-28 at an interval significantly less than the currently required interval to provide multiple opportunities for detecting any improperly installed or fractured attachment hardware or fittings. Require operators to report findings to the FAA. (A-22-29) (Urgent)

To Transport Canada:

Require operators of Bell 407 helicopters to conduct an immediate torque check of the tail boom attachment hardware, as well as a visual inspection of the tail boom attachment fittings for evidence of cracks and fractures, and report findings to Transport Canada. (A-22-30) (Urgent)

Require operators of Bell 407 helicopters to conduct subsequent torque checks of the tail boom attachment hardware and visual inspection of the tail boom attachment fittings as referenced in Safety Recommendation A-22-30 at an interval significantly less than the currently required interval to provide multiple opportunities for detecting any improperly installed or fractured attachment hardware or fittings. Require operators to report findings to their respective regulatory authority. (A-22-31) (Urgent)

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