K&S Helicopters, Inc.
d/b/a Paradise Helicopters
73-341 U'u St.
Kailua-Kona, HI 96740

National Transportation Safety Board
490 L'Enfant Plaza, SW
Washington, DC 20594
Attn: Aaron Sauer – Lead Investigator

Party Submission: ***49 CFR 831.14***
Accident Number: ANC22FA041

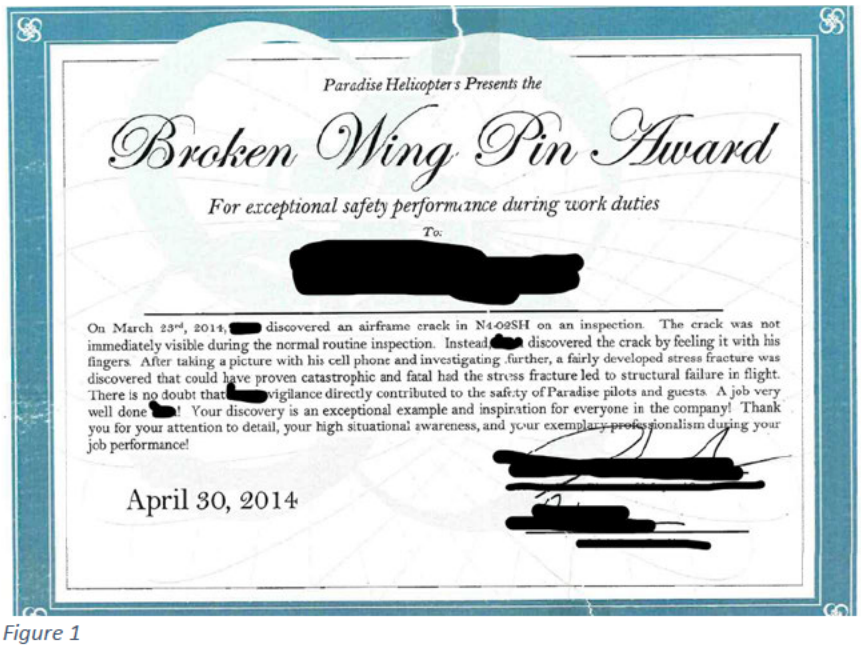
Proposed Findings

There is a long history of Bell 407 tailboom manufacturing issues that Bell has addressed throughout the 25+ years of aircraft production. Bell issued at least 16 Bulletins which apply to the accident serial number. These bulletins address the significant issues with structural integrity of the Bell 407 tailbooms and associated airframe attach points and hardware.

K&S Helicopters, Inc. – N402SH Accident

N402SH tailboom at the time of the accident was installed at 5,780 airframe hours. The aft bulkhead and upper left longeron was repaired IAW TB 407-12-96 following discovery of a stress fracture in 2014.

On March 23, 2014, one of the operator's maintenance managers found a stress fracture during an inspection. It could not be seen during a visible inspection but instead was found through feeling the affected area. The employee was presented with a safety award for his finding. (**see *Figure 1***)



Paradise Helicopters Presents the

Broken Wing Pin Award

For exceptional safety performance during work duties

To: [redacted]

On March 23rd, 2014, [redacted] discovered an airframe crack in N402SH on an inspection. The crack was not immediately visible during the normal routine inspection. Instead [redacted] discovered the crack by feeling it with his fingers. After taking a picture with his cell phone and investigating further, a fairly developed stress fracture was discovered that could have proven catastrophic and fatal had the stress fracture led to structural failure in flight. There is no doubt that [redacted] vigilance directly contributed to the safety of Paradise pilots and guests. A job very well done [redacted]! Your discovery is an exceptional example and inspiration for everyone in the company! Thank you for your attention to detail, your high situational awareness, and your exemplary professionalism during your job performance!

April 30, 2014

[redacted]

Figure 1

According to Phoenix Heliparts Inc. work order No. 1105, signed on July 3, 2014, assistance was provided to accomplish Bell TB No. 407-12-96 Revision A on the accident helicopter.

The repair station completed a majority of the steps of the TB including steps 8 through 25. These steps reference the procedure for creation of the drill plate, installation, clamping, gap measurements and confirmation of correct planing for all longeron fittings.

(See **Figure 2**)

MAKE: Bell
MODEL: 407
S/N: 53118
REG. NO: N402SH
WORK ORDER: 1105

Phoenix Heliparts Inc.
3130 N. Oakland, Suite 110
Mesa, Arizona 85215 USA
Phone: 480-985-7994

DATE: 7/3/2014
A/C TSN: 14956
TACH:

Airframe Entries

2 Performed an A/C Preliminary and receiving Inspection. Reviewed Logbooks and photographed aircraft records. Performed verification of Aircraft Information; registration number, part number, serial number, general condition, obvious damage and the possibility that hidden damage inspection may be required.

Found aircraft in the following condition:
Aircraft in good condition. Engine, Transmission, Tailboom, and upper aft skin removed.

Description of discrepancy found (if different than reported):
Crack in LH engine pan longeron and in clip at RH engine pan longeron at fs 192.00

Description of any additional material, equipment, tooling, data or personnel required by actual discrepancies versus what was reported:
Procedure and hardware for replacement of LH engine pan longeron.

Arrival Date: April 30, 2014, A/C Model: Bell 407, A/C Registration: N402SH, A/C S/N: 53118 TT: 14,956.2

3 Provided assistance for TB 407-12-96 Rev. A dated 14 Feb. 2012, performed the following steps of the Technical Bulletin Accomplishing Instructions- steps 5, 8 thru 25, 31 thru 34. Customer to comply with remaining items.
Replaced damaged skin p/n 206-033-003-161 and LH and RH retainers P/N 407-030-740-116S and 407-030-740-115S with new customer supplied parts. Removed and installed referencing TB 407-12-96 Rev.A Dated 14 Feb. 2012 and BHT-All-SRM 3-3-1.

5 Removed L/H aft fuselage skin to gain access to the L/H engine pan longeron P/N 206-031-314-173, Removed cracked L/H engine pan longeron P/N 206-031-314-173 and installed new customer supplied longeron and Reinstalled L/H aft fuselage skin Referencing BHT-206-SRM-1 section 6 application 6-2-6. Determined to be a major Repair.

6 Repaired damaged frames at sta.167.33 and 179.66, and 192.00 LBL 13.00. Determined to be a major Repair.

Repaired damaged frame at sta.167.33 (P/N 206-032-303-129) by splicing in new frame section from LBL 7.75 to LBL 23.0, Fabricated upper splice repair from 7075T6 .032 P.O. 10256 referencing BHT-ALL-SRM 3-6-3, Fabricated lower splice from new frame segments and 7075T6.032 P.O.10256 referencing BHT-206-SRM-1 5.2.4. Treated and primed all repair parts referencing BHT-ALL-SPM 3-16.

Repaired damaged frame at sta.179.66 by fabricating repair clip and shim from 7075T6.032 P.O.10256 increasing the dimensions of the clip to add fasteners around damage, repair clip replaces P/N 206-032-304-007 clip,fabricated repair doubler from 7075T6.032 P.O.10256 to repair damage to doubler P/N 206-032-304-029 referencing BHT-ALL-SRM 3-6-3 application C. Treated and primed all repair parts referencing BHT-ALL-SPM 3-16.

Repaired damaged frame at sta.192.00 by fabricating a doubler from 2024T3.040 P.O.12839 for the forward side of the frame and a doubler for the aft side of frame from customer supplied 2024T3.032 referencing BHT-ALL-SRM 3-5-4. Fabricated replacement clips from 2024T3.040 P.O. 12839 P/N PH206-032-305-161, -162 and reinstalled, Treated and primed all repair parts referencing BHT-ALL-SPM 3-16.

Technicians Who Worked On The Items Listed Above:
Brandon Clausen, Donald Degray, Ismael De Larosa, Ryan Howe, Ted Manchego, Travis Pithoud

The work described in Work Order 1105, was performed in accordance with 14 CFR and with respect to that work, the article described in the referenced Work Order is approved for return to service. Pertinent details of the repair are on file at Phoenix Heliparts, Inc. Work Order No. 1105.

DATE: 7/3/2014 SIGNED [redacted] Work Order: 1105

CRS#: X8HR308Y

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Figure 2

Additional Work Order documentation from Phoenix Heliparts Inc. for Work Order 1105 in support of TB 407-12-96 Rev. A. The Work Order shows that the repair station contacted Bell Tech support for repair schemes and technical support for the damage found by the operator. (See ***Figure 3***)

Aircraft Discrepancy Report

1. Originator					
Work Order No.:	1105	A/C Reg #:	1105	Originating Ebis Item:	3
Discrepancy:					
Additional time needed to support the repair from Phoenix.					
Contact Bell Tech support for repair schemes, Research repairs in the 407 Manuals, Technical support					
Entered by: [redacted]				Date:	5/12/14
2. Department Manager					
Planned Action:					
☐ PHP Rework – No charge to customer		Audit and Action Form #			
Est hrs: 15	Entered by: [redacted]			Date:	5/12/14
3. Inspection/QA					
Form 421#: N/A	Repair: ☐ Alteration: ☐ N/A: ■		Major: ☐ Minor: ☐ N/A: ■		
8110-3 Required: Yes ☐ No ■	Inspector:			Date:	5/12/14
101 Scanned to Ebis: (Originating Item) ■					
4. Department Manager					
Department: Planning	Pending Ebis Item/s: 3	*Est Lbr $ [redacted]	*Est Parts $ N/A		
*Est Eng/DER/OSR $: N/A	Quote#: N/A	Ebis Quote attached: Yes ☐ No ☐ N/A ☐			
Mana[redacted]					
Required approval by date:		*Total Estimate: $[redacted]			
** Customer Approval Signature:				Date:	
6. PHP Customer Technical Support Approval					
Ebis Item Approved and 101 uploaded to Billing item: Yes ☐ No ☐	Approved by:			Date:	

*Estimate based on PHP projection of the work to be performed and may not cover any additional parts and/or labor which may be required after the work has begun.
** Phoenix Heliparts Inc. will not proceed without Customer Approval Signature.

Form 101 – Rev. NC – 3/12/2014 | File Name: - Form 101

Figure 3

Per the NTSB Factual Report:

According to Bell Alert Service Bulletin (ASB) No. 407-11-95 and Federal Aviation Administration (FAA) Airworthiness Directive (AD) No. 2015-05-04, installation of upper-left longeron assembly P/N 206-031-314-237B and installing three external strap doublers ***constitutes terminating action*** *for the ASB and AD, respectively. Revision D of Bell ASB No. 407-11-95, issued on August 21, 2020, introduced a new 2-piece upper-left longeron assembly, P/N 407-030-067-105, which could be installed via Bell Technical Bulletin (TB) No. 407-17-125.*

On May 4, 2022, AD2012-18-09 was performed to comply with the 300 hour torque checks of the tailboom attach bolts. No discrepancies were noted 34 days prior to the accident. The torque values were in range and all bolts were installed. 114.2 hours later, the aircraft accident occurred.
(see ***Figure 4***)

AIRCRAFT MAINTENANCE WORKSHEET

AIRCRAFT TYPE: B407 | REGISTRATION: N402SH | DATE: 5/29/2022

#	DISCREPANCY	#	CORRECTIVE ACTION/SIGNATURE/CERT.#/ACTT OR ENG TT.
9	100 HOUR AFS INLET BARRIER FILTER INSPECTION DUE PER ICA FOR STC SR09368RC.	9	COMPLETED 100 HOUR AFS INLET BARRIER INSPECTION I.A.W. AFS ICA AFS-B407-IBF-KIT-ICA. NO DISCREPANCIES NOTED AT THIS TIME. SIGNATURE [redacted] CERT: [redacted] ACTT: 2079.9
10	100 HOUR AIR CONDITIONING DRIVE RING AND PULLEY INSPECTION DUE PER SB 407-300-1.	10	COMPLIED WITH 100 HOUR AIR CONDITIONING DRIVE RING AND PULLEY INSPECTION I.A.W. BELL IL 407-14-106 AND AIR COMM SB 407-300-1. NO DISCREPANCIES NOTED. SIGNATURE: [redacted] CERT: [redacted] ACTT: 2079.9
11	AD 2015-05-04 DUE.	11	COMPLIED WITH AD 2015-05-04 BY VISUALLY INSPECTING THE AFT FUSELAGE UPPER SKIN AND LONGERON FOR CRACKS. NO DISCREPANCIES NOTED AT THIS TIME. SIGNATURE: [redacted] CERT: [redacted] ACTT: 2079.9
12	21 DAY ENGINE WASH DUE.	12	PERFORMED 21 DAY ENGINE WASH IRW RR250-C47B MM CH. 72. SIGNATURE: [redacted] CERT: [redacted] ACTT: 2079.9
13	CEB A-72-6085 DUE.	13	COMPLIED WITH INSPECTION OF OUTER COMBUSTION CASE FOR CRACKS IRW CEB A-72-6085. NO DISCREPANCIES NOTED AT THIS TIME. SIGNATURE: [redacted] CERT: [redacted] ACTT: 2079.9
14	100 HOUR RADAR ALTIMETER MOUNT KIT INSPECTION DUE FOR STC SR02162LA.	14	COMPLETED 100 HOUR INSPECTION OF AERONAUTICAL ACCESSORIES RADAR ALTIMETER MOUNT KIT IAW AA-TBA-16-008 INSTRUCTIONS FOR CONTINUED AIRWORTHINESS. NO DISCREPANCIES NOTED AT THIS TIME. SIGNATURE: [redacted] CERT: [redacted] ACTT: 2079.9

AIRCRAFT MAINTENANCE WORKSHEET - PMX 001 REV 3 - 11/20/2013

Figure 4

In addition to this torque check, multiple Airworthiness Directives for the Tailboom and Longeron were completed including AD2012-18-09, AD2015-05-04, AD2013-12-07, ASB 407-21-123 with no defects noted.

Despite the operator completing the terminating action for the ASB and AD referenced above, the operator continued to perform AD2015-05-04 inspection. The inspection for the AD was last performed on May 29, 2022 – 10 days prior to the accident (See ***Figure 5***). This inspection required a mechanic to physically look at the interior area of the tailboom at the location of longerons to specifically look for cracking and perform a visual inspection every 50 hours. 10 days prior to the accident, even after a terminating action was performed in 2014, two Bell-approved forms of inspection; a repair constituting a terminating action and repeated visual inspections, did not lead to the identification of any longeron cracking, notice of a bolt missing, misalignment or any other potential cause for a catastrophic structural failure that was just days away from happening.

AIRCRAFT MAINTENANCE WORKSHEET

AIRCRAFT TYPE: B407 | N402SH | DATE: 5-4-2022

10	100 HOUR AIR CONDITIONING DRIVE RING AND PULLEY INSPECTION DUE PER SB 407-300-1.	10	COMPLIED WITH 100 HOUR AIR CONDITIONING DRIVE RING AND PULLEY INSPECTION I.A.W. BELL IL 407-14-106 AND AIR COMM SB 407-300-1. NO DISCREPANCIES NOTED. SIGNATURE [redacted] CERT: [redacted] ACTT: 22891.4
11	300 HOUR HYDRAULIC FILTER REPLACEMENT DUE.	11	COMPLETED 300 HOUR HYDRAULIC FILTER REPLACEMENT I.A.W. BHT-407-MM-1 CH. 29. SIGNATURE: [redacted] CERT: [redacted] ACTT: 22891.4
12	300 HOUR OPTIONAL EQUIPMENT INSPECTION DUE.	12	COMPLIED WITH 300 HOUR OPTIONAL EQUIPMENT INSPECTION I.A.W. BHT-407-MM-1 CH. 5. NO DISCREPANCIES NOTED. SIGNATURE: [redacted] CERT: [redacted] ACTT: 22891.4
13	AD 2012-18-09 RE-TORQUE OF TAILBOOM ATTACH NUTS DUE.	13	COMPLETED RE-TORQUE OF TAILBOOM ATTACH NUTS I.A.W. AD 2012-18-09. SIGNATURE: [redacted] CERT: [redacted] ACTT: 22891.4
14	300 HOUR HELI-ACCESS STEP INSPECTION DUE PER ICA FOR STC SR00915SE.	14	COMPLIED WITH 300 HOUR HELI-ACCESS STEP INSPECTION I.A.W. DART ICA/MMS-D206-628. NO DISCREPANCIES NOTED. SIGNATURE: [redacted] CERT: [redacted] ACTT: 22891.4
15	300 HOUR HIGH VISIBILITY DOOR KIT INSPECTION DUE PER ICA FOR STC SR09376RC-D.	15	COMPLIED WITH 300 HOUR HIGH VISIBILTY DOOR KIT INSPECTION I.A.W. AERONAUTICAL ACCESSORIES ICA AA-05158. NO DISCREPANCIES NOTED. SIGNATURE: [redacted] CERT: [redacted] ACTT: 22891.4
16	300 HOUR COMPASS INSPECTION PER ICA FOR STC SR00486DE.	16	COMPLIED WITH 300 HOUR COMPASS INSPECTION I.A.W. PARAVION ICA PR-407LS-120M. NO DISCREPANCIES NOTED. SIGNATURE: [redacted] CERT: [redacted] ACTT: 22891.4
17	300 HOUR PULSELITE INSPECTION DUE PER ICA FOR STC SA00560SE.	17	COMPLIED WITH 300 HOUR PULSELITE INSPECTION I.A.W. PRECISEFLIGHT ICA 015PMAN0001. NO DISCREPANCIES NOTED. SIGNATURE: [redacted] CERT: [redacted] ACTT: 22891.4
18	300 HOUR CROSSTUBES INSPECTION DUE PER ICA FOR STC SR09330RC.	18	COMPLIED WITH 300 HOUR CROSSTUBES INSPECTION I.A.W. AERONAUTICAL ACCESSORIES ICA AA-00061. NO DISCREPANCIES NOTED. SIGNATURE: [redacted] CERT: [redacted] ACTT: 22891.4

Figure 5

After the accident occurred, the operator conducted eddy-current non-destructive inspection (NDI) on the aft fuselage longerons of their remaining Bell 407 helicopter fleet. On N807PH, NDI found cracking indications on the aft faying surface of the lower-left longeron bolt hole and within the bolt hole of the upper-left longeron. (See ***Figure 6***)

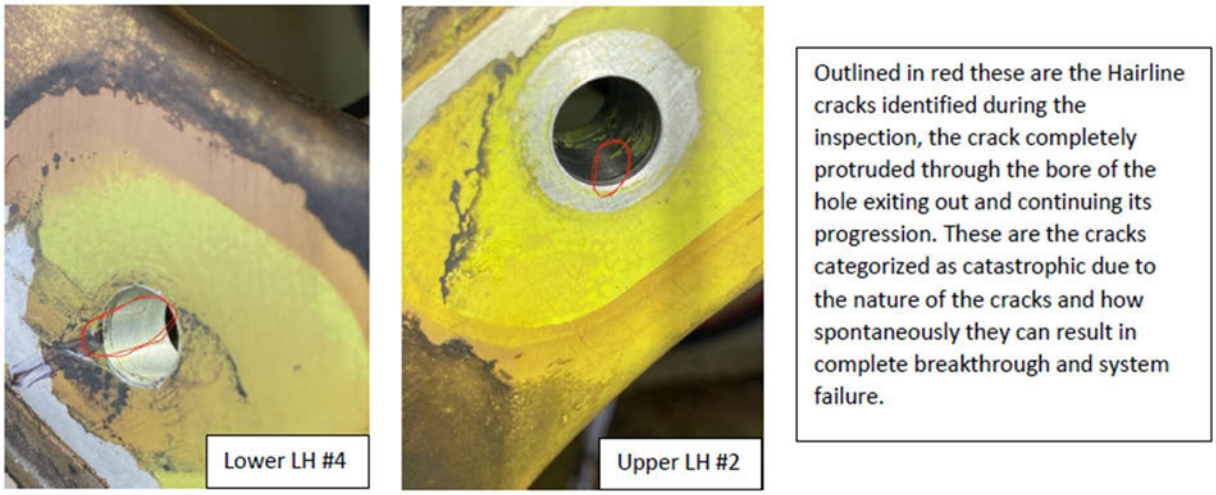


Figure 6

At the request of the NTSB, the Bell FI Lab conducted an examination of the two longerons, and concluded that the cracks were the result of fatigue.

N807PH tailboom at the time of the NDI in June of 2022 was the original tailboom installed at time of manufacturing.

On March 28, 2022, AD2012-18-09 Torque check of tailboom attach bolts was satisfactorily completed.

On May 10, 2022, AD 2015-05-04 was completed through visual inspection of aft fuselage upper skin and longeron for cracks. No discrepancies were noted.

N807PH did not have any maintenance record of completion of TB407-07-78 or TB 407-12-96. The operator's executive team reviewed all company historical maintenance records related to the aircraft and could not find a time when work was performed on the tailboom, longerons nor aft fuselage bulkhead that could result in misalignment of the aft fuselage bulkhead. The only known time the tailboom was removed was for shipping the helicopter to the operator.

The Bell Field Investigations Laboratory performed analyses on an ***additional*** two separate aircraft related to issues with Model 407 tail boom attach fittings that were not related to the accident operator.

Aircraft with Lower Left Cracked Fitting

Per the NTSB Group Chair's Factual Report - Addendum document:

One report covered a lower-left fitting that had a relatively slower growing fatigue crack without any coinciding issues at the upper-left location (FI Report: 40708M-007). A comparison of the fatigue features indicated that the lower-left fitting covered in this report experienced relatively higher loads than an aircraft with a properly fastened upper-left joint.

Bell 407 S/N 53563 – Bolt Fracture

Per the NTSB Group Chair's Factual Report - Addendum document:

The second report covered a fractured bolt at the upper-left location with no coinciding cracks in the lower-left fitting (FI Report: 40719M-071). This occurrence indicated that a bolt fracture at the upper-left location can occur without a crack having formed in the lower-left fitting.

Neither of the previous issues resulted in an incident, and both were discovered during inspections.

The Airworthiness Group Chair's Factual Report for this investigation, dated October 24, 2022 and found in the docket for this investigation, discussed a past occurrence involving a Bell 407 in which the operator found a fractured upper-left attachment bolt during a scheduled 300-hour recurring torque check. Metallography of the fractured bolt found multiple-origin fatigue cracking through about 2/3 of the fracture cross-section, with the remainder of the fracture cross-section in overload. The location of the fracture on the bolt was estimated to be co-located with the aft face of the aft fuselage bulkhead.

The fractured bolt found on Bell 407 S/N 53563. (Image courtesy of Bell)

B407 – Finding Commonality

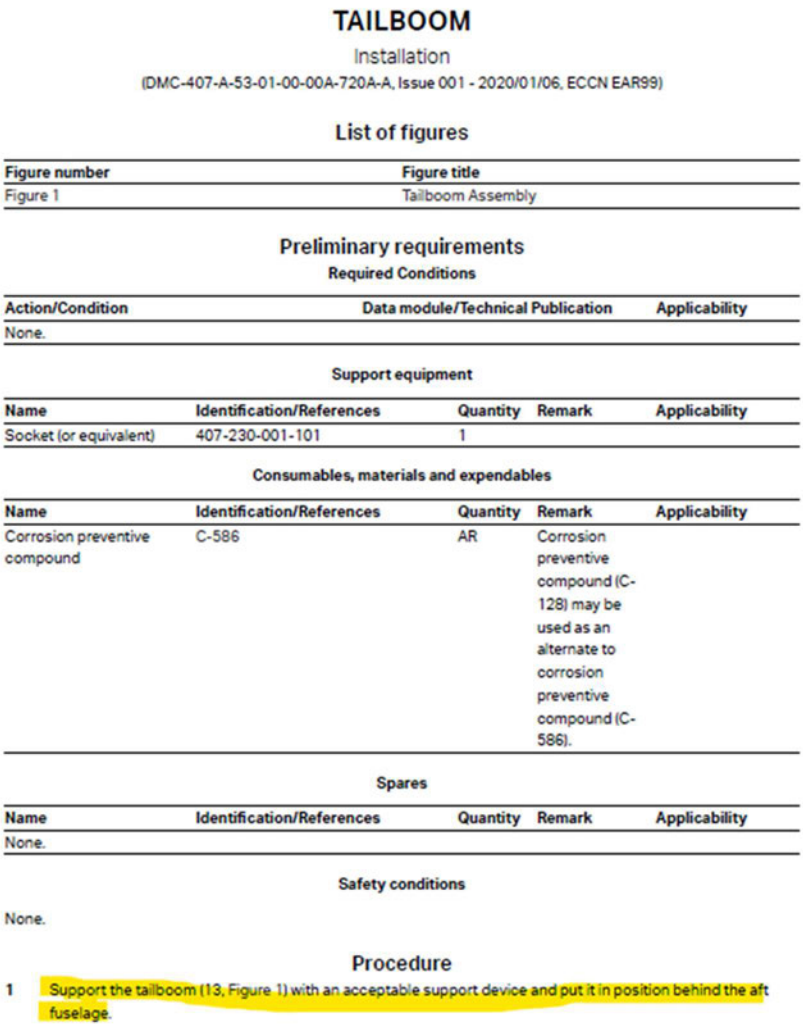
In reviewing the records and known information of the 3 primary Bell 407 events that have the most similar results, it is difficult to find a common trend that ultimately shows the direct cause or scenario that leads to the opportunity for misalignment.

In all three cases, the only common event is the removal and reinstallation of the tailboom at some point in the aircraft maintenance history. (See *Figure 7*)

	N402SH [Accident A/C]	N807PH [Operator] (Bolt Hole Cracks)	B407 SN 53563 (Fractured Bolt)
Original Tailboom		X	
Complied with TB 407-12-96	X		X
Tailboom Removed	X (TB)	X (Shipping)	X (TB)

Figure 7

Upon review of Bell Maintenance Manual Chapter 53 for Tailboom installation instructions, Step 1 of the Procedure is to "Support the tailboom with an acceptable support device". There is no further details to provide any more specific or detailed instructions to avoid possible misalignment and resulting fractures in the tailboom assembly and components during tailboom installation. (See *Figure 8*)



TAILBOOM

Installation

(DMC-407-A-53-01-00-00A-720A-A, Issue 001 - 2020/01/06, ECCN EAR99)

List of figures

Figure number	Figure title
Figure 1	Tailboom Assembly

Preliminary requirements

Required Conditions

Action/Condition	Data module/Technical Publication	Applicability
None.		

Support equipment

Name	Identification/References	Quantity	Remark	Applicability
Socket (or equivalent)	407-230-001-101	1		

Consumables, materials and expendables

Name	Identification/References	Quantity	Remark	Applicability
Corrosion preventive compound	C-586	AR	Corrosion preventive compound (C-128) may be used as an alternate to corrosion preventive compound (C-586).	

Spares

Name	Identification/References	Quantity	Remark	Applicability
None.				

Safety conditions

None.

Procedure

1 Support the tailboom (13, Figure 1) with an acceptable support device and put it in position behind the aft fuselage.

Figure 8

Proposed Probable Cause

Catastrophic material failure of upper left hand tailboom bolt leading to the transfer of load and ultimate separation of the tailboom from the fuselage.

Contributing Factors:

Failure of Bell to design and manufacture damage-tolerant longerons and tailboom bolts under normal operation.

Lack of any required inspections mandated by Bell and the FAA that have the capability to identify corrosion, subsurface damage or material abnormalities in the tailboom bolts, bolt holes, longerons and longeron fittings that can lead to fatigue and ultimate structural failure.

Failure by manufacture to require measurement of any gap after installation of the longeron to confirm proper installation when incorporating TB 407-12-96.

Lack of procedures or inspections that would confidently identify a misaligned longeron fitting or aft bulkhead following replacement.

Proposed Safety Recommendations

Minimum Required Action:

- Reduction of 300hr torque checks under AD2012-18-09 reduced to *less than 100 hour interval*
    - Recommend performance at every maintenance Event (50 hours)
    - Recommend change to calculating time between torque checks to 100 *cycles* including cargo hook loads.

Additional Preventative Action:

Recurring eddy Current NDI inspection of Bell 407 fleet with tailboom removed for access and inspections of misalignment or gaps, and inspection or replacement of hardware.

Revise TB 407-12-96 and TB 407-07-78 to incorporate the review and measurement of any gap following installation of the longeron to confirm proper planing.

Revise Bell 407 Maintenance manual to provide more specific instructions on the proper support of the tailboom during installation with procedures that will eliminate the potential for misalignment.

Final Comments

Following its investigation, the NTSB recommended that operators of Bell 407 helicopters immediately conduct (1) a torque check of the tailboom attachment hardware, and (2) a visual inspection of the tailboom attachment fittings for evidence of cracks and fractures. Id. at 6-7. In addition, the NTSB recommended that the Federal Aviation Administration ("FAA") require operators of Bell 407 helicopters to conduct all ensuing tailboom torque checks and visual inspections at an interval significantly less than what was previously required. To date, the FAA and Bell have not implemented anything beyond a one-time inspection and torque check.

The actions taken by Bell and the FAA to date will not prevent this accident from occurring again to another operator.

There is a known issue with the Bell 407 tailboom, aft bulkhead, longerons and non-standard alignments causing cracking in the critical structures of the tailboom leading to the failure of tailboom bolts. Today, there are no required inspections that would allow for the identification of a problem, at any point in the chain reaction, leading to another accident. A break in the error chain needs to be implemented immediately. Miraculously, 6 people survived an un-survivable accident. The next group won't be as fortunate if we allow there to be a "next time".